Republic of the Philippines
**DEPARTMENT OF ENERGY**

April 6, 2018

REQUEST FOR COMMENTS

The Oil Industry Management Bureau through the Oil Industry Standards and Monitoring Division in cooperation with the Technical Committee on Petroleum Processes and Facility (TCPPF) has just completed the review/update/revision of PNS/DOE FS 2:2006 LPG Refilling Plant – General Requirements. This is in compliance with the Bureau of Philippine Standards Directives, Part 1, 2.8 Maintenance of standards which states that:

> *"Every Philippine National Standard (PNS) shall be subjected to systematic review in order to determine whether it should be reconfirmed, amended/revised or withdrawn at least every five (5) years or as the need arises due to market requests, technological and other acceptable reasons."*

Enclosed is a copy of the reviewed/updated/revised draft PNS/DOE FS 2:2018 LPG Refilling Plant – General Requirements which is being circulated to all concerned sectors from April 13 - June 13, 2018 for comments. We appreciate receiving your comments on or before June 13, 2018. Non-receipt of your comments on the specified date shall be construed as your concurrence to the draft PNS/DOE FS 2:2018 LPG Refilling Plant – General Requirements.

Thank you for your usual cooperation.

**Director RINO E. ABAD**
Chairman – TCPPF
OIC, OIMB

ERH/ZGL/ADTL

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**Foreword**

This Philippine National Standard on Liquefied Petroleum Gas (LPG) Refilling Plant PNS/DOE FS 2:2018 was prepared by the Department of Energy's Technical Committee on Petroleum Processes and Facilities (TC-68) through a Technical Working Group for LPG refilling plant and was approved for adoption as Philippine National Standard by the Department of trade and Industry/ Bureau of Product Standards (DTI/BPS).

In the preparation of this standard, the following safety Codes were considered:

Code of Safety Practice in LPG Refilling Plant
National Fire Code of the Philippines 2008 (R.A. 9514)
PLPGA Safety Code
NFPA 58, Liquefied Petroleum Gas Code
NFPA 59, Utility LP-Gas Plant Code

This version amends and replaces PNS FS 2:2006 LPG Refilling – General Requirements.

Further, this edition incorporates a new chapter adopting energy resiliency in the planning and programming of the energy sector to mitigate potential impacts of disaster. It also takes into account additional operational or design parameters brought about by effects of localized weather conditions and other disruptive natural events that facility owners/operators must consider.

**PHILIPPINE NATIONAL STANDARD** **PNS/DOE FS 2:2018**

**LPG refilling plant – General requirements**

## 1 Scope

This standard covers the requirements for the installation of an LPG Refilling Plant, including the associated bulk storage tank facility and other related equipment and facilities.

NOTE 1 This standard does not cover refrigerated storage facilities.

NOTE 2 Any Auto-LPG dispensing system to be located within an LPG refilling plant shall be separated from the latter by a firewall and shall be provided with a separate access.

NOTE 3 The requirements for the installation and conduct of dispensing of LPG for vehicles are covered by a separate standard, PNS for Auto-LPG Dispensing Stations.

NOTE 4 Any cylinder maintenance facility especially with hot work activities shall not be located within an LPG refilling plant. If ever such facility will be installed it shall be separated from the refilling plant by a firewall and shall be provided with a separate access.

## 2 References

The titles of the standards publications referred to in this standard are listed on the inside back cover.

## 3 Definitions

For the purpose of this standard the following definitions shall apply.

**3.1**
**approved**
acceptable to the authority having jurisdiction

**3.2**
**attended**
presence of competent person within the operating facilities at all times

**3.3**
**authority having jurisdiction (AHJ)**
an organization, agency, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure. Normally this refers to a government regulatory body.

**3.4**
**code**
a standard that is an extensive compilation of provisions covering broad subject matter or that is suitable for adoption into law independently of other codes and standards

**3.5**
**above ground storage tank**
a tank or pressure vessel where all parts of which are exposed above grade

**3.6**
**bulk plant**
a facility where the primary function is to store LPG prior to further distribution. Plant received LPG through cargo tank vehicles or through pipelines from ship tankers and then distributed to consumer by portable container called cylinder or by bulk in cargo tank vehicles.

**3.7**
**bullet tank**
a horizontal tank or pressure vessel with a cylindrical body and two (2) hemispherical ends.

**3.8**
**bund walls**
walls of earth or concrete construction that completely surrounds a tank for the purpose of containment of product in case of leak.

**3.9**
**buried or underground tank**
a tank or pressure vessel all parts of which (except the manhole) are completely buried below the surrounding or general grade of facility.

**3.10**
**container**
any pressure vessel including cylinder, portable tank, stationary bulk tank, mobile cargo tank vehicle, used for storing, handling and transporting of LPG.

**3.11**
**cylinders**
a portable container designed, manufactured, tested, examined and marked in accordance with the Philippine National PNS 03-1: 2014 – Transportable and refillable steel cylinders for LPG- Part 1 Specifications. The capacity permitted under this specification is up to and including 150 L water capacity, exposed to ambient temperature.

**3.12**
**field-erected tank**
a tank that is fabricated in whole or in part at or near its final location.

**3.13**
**fire protection**
fire protection for the purposes of this code shall be defined in the broad sense to include fire prevention, fire detection, and fire suppression.

**3.14**
**installations**
tanks or pressure vessels, pumps, compressors, pipelines, valves, accessories and all other associated equipment required for the receipt, transfer, storage and shipment of LPG.

**3.15**
**LPG**
a gas liquefied by compression or by lowering its temperature consisting of hydrocarbon predominantly propane ($C_3H_8$), butane ($C_4H_{10}$) or their mixture; liquefied petroleum gas in either the liquid or vapor state. The more specific terms *liquid LP-Gas* or *vapor LP-Gas* are normally used for clarity.

**3.16**
**maximum allowable working pressure**
the maximum pressure at which a container or pressure vessel will operate based on the maximum vapor pressure of the actual grade (mixture and highest temperature) the LPG content will attain as described by NFPA 58 and by ASME Boiler and Pressure Vessel Code.

**3.17**
**mounded tank or vessel**
a tank or pressure vessel located above or partially above the general grade level but covered with earth, sand or other suitable material. A tank designed for underground service installed above the minimum depth required for underground service and covered with earth, sand, or other material.

**3.18**
**psia**
pounds per square inch, absolute (atmospheric pressure + gauge pressure reading)

**3.19**
**psig**
pounds per square inch gauge (pressure read by gauge)

**3.20**
**refilling plant**
shall refer to any installation that is used for refilling LPG into cylinders and has LPG bulk storage and refilling facilities thereof.

**3.21**
**resiliency**
the ability of a system, community or society exposed to hazards to resist, absorb, accommodate and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and function

**3.22**
**shop-fabricated tank**
a container or pressure vessel that is completely fabricated within a fabricated shop under shop-controlled conditions.

**3.23**
**sources of ignition**
devices or equipment that, because of their modes of use or operation, are capable of providing sufficient thermal energy to ignite flammable LPG vapor-air mixtures when introduced into such a mixture or when such a mixture comes into contact with them, and that will permit propagation of flame away from them

**3.24**
**shall**
indicates provision that is mandatory

**3.25**
**should**
a provision that is highly recommended but not mandatory

**3.26**
**single trip cylinders**
non-refillable or disposable LPG containers or canisters that are intended for single use only and shall not be refilled after each use for safety reasons.

**3.27**
**water capacity**
total volume of tank or pressure vessel in water, expressed in liters, gallons, $m^3$ or $ft^3$

## 4 LPG bulk storage tank

This clause covers the requirements for aboveground, underground, buried and mounded pressurized LPG storage tanks.

### 4.1 General requirements

**4.1.1** Aboveground LPG storage tanks should be grouped in rows and not in blocks. Horizontal tanks like "bullet" tanks shall be placed in parallel and not in line or at right angles to one another, as there exist a possibility that, if involved in a fire, tanks may be displaced along their longitudinal axis.

**4.1.2** The site or location of tank shall consider the direction of the prevailing wind in the area or locality, i.e. storage tank shall be located downwind of other facilities such that in case of product leak the other facilities are in the opposite direction of the path of leak.

**4.1.3** The tank shall be located or sited in an area that is accessible to fire-fighting equipment and vehicles that can access the area without any obstruction.

**4.1.4** The tank area location and topographical nature allows that in case of LPG leak the flow is far as possible from possible ignition sources, important work areas and the LPG is dispersed and diluted easily.

**4.1.5** The number of connections or nozzles on tank or pressure vessel below the maximum liquid level (i.e. below the vapor space) should be reduced to a minimum.

**4.1.6** Only piping directly associated with the storage tank shall be located within the storage area.

**4.1.7** All pipelines connected to the tank shall be adequately supported in such a way that forces and bending moments on the tanks are kept within acceptable limits.

### 4.1.8 Tank design, material and construction

**4.1.8.1** LPG tank design, materials, construction, inspection and testing shall be in accordance with ASME Code Section VIII Division 1, Section VIII Div. 2 or other equivalent international accepted Code or Standard for unfired pressure vessel. For mounded tank, in addition to ASME Codes, the design, materials, construction, inspections and testing shall be supplemented/ augmented by Standard EEMUA Publication 190 – Guide for the Design, Construction and Use of Mounded Horizontal Cylindrical Steel Vessels for Pressurized Storage of LPG at ambient temperatures.

**4.1.8.2** The design pressure of LPG tank shall not be less than the maximum vapor pressure of the actual grades of LPG to be handled at the highest or maximum temperature that the contents will reach during normal service.

**4.1.8.3** The tank shall be designed for the Upper Design Temperature (UDT) and Lower Design Temperature (LDT). The recommended UDT is 40 °C and LDT is 0 °C.

**4.1.8.4** Materials used for LPG tank shall be suitable for use at the lowest temperature the contents will reach in normal service, which may be below the minimum ambient temperature, and shall in any event be suitable for use at $0^{\circ}$ C.

**4.1.8.5** The design pressure to be used at the top of the tank shall be equal to the maximum vapor pressure of the product (LPG, propane or butane) corresponding to the maximum temperature mentioned above plus allowance to ensure that in normal operation, PRV do not open. This allowance is normally 10% or 1.7 bars above the vapor pressure whichever is greater.

**4.1.8.6** The maximum vapor pressure attain by an LPG to be used shall be the basis for the tank maximum allowable working pressure (MAWP) or minimum design pressure and shall be in accordance with Table 1.

**4.1.8.7** Shop fabricated containers shall be fabricated and provided with lifting lugs and sufficient pads or doubler plates for lifting the container or tank.

**4.1.8.8** Field-erected LPG tank shall be built in accordance with ASME Boiler and Pressure Vessel Code except that design and construction using joint efficiencies that do not specify radiography (RT) shall not be allowed or permitted (ASME Code Section VIII Div. 1, Table UW 12, Column C).

**4.1.8.9** Tank having a capacity of more than 20,000 liters shall be subjected to Environmental Impact Assessment process, refer to DENR regulations.

**Table 1 – Maximum Vapor Pressure and Maximum Allowable Working Pressure (MAWP)**

| Maximum Vapor Pressure at 37.8 °C (100 °F) not to exceed | Maximum Allowable Working Presure (MAWP) or Minimum Design Pressure | | |
|---|---|---|---|
| | Current ASME Code | Earlier Codes | |
| | | API-ASME | ASME |

| PSIG | MPaG | psig | MPag | PSIG | MPaG | psig | MPag |
|---|---|---|---|---|---|---|---|
| 80 | 0.6 | 100 | 0.7 | 100 | 0.7 | 80 | 0.6 |
| 100 | 0.7 | 125 | 0.9 | 125 | 0.9 | 100 | 0.7 |
| 125 | 0.9 | 156 | 1.1 | 156 | 1.1 | 125 | 0.9 |
| 150 | 1.0 | 187 | 1.3 | 187 | 1.3 | 150 | 1.0 |
| 175 | 1.2 | 219 | 1.5 | 219 | 1.5 | 175 | 1.2 |
| 215 | 1.5 | 250 | 1.7 | 250 | 1.7 | 200 | 1.1 |
| 215 | 1.5 | 312 | 2.2 | 312 | 2.2 | - | - |

### 4.1.9 LPG bulk storage tank markings

**4.1.9.1** LPG bulk storage tank shall be identified by the attachment of a nameplate.

**4.1.9.2** The markings specified shall be on a stainless steel nameplate attached to the container and located to remain visible after the container is installed.

**4.1.9.3** The nameplate shall be attached so as to minimize corrosion of the nameplate or its fastening means and so as not to contribute to corrosion of the container due to galvanic corrosion.

**4.1.9.4** Where the tank is buried, mounded, or otherwise covered so as to obscure the nameplate and data, the nameplate shall be installed or duplicated on adjacent piping or on a structure that is directly attached to the tank such as manholes or domes in a clearly visible manner.

**4.1.9.5** The bulk storage tank Nameplate shall contain the following minimum information or data:

a) Name and address of the tank manufacturer;
b) Manufacturer's designated serial number;
c) Water capacity of the tank in liters, gallons, $m^3$ or $ft^3$;
d) Design or maximum allowable working pressure (MAWP) in MPa, PSI, $kg/cm^2$ or bars;
e) Outside surface area (OSSA) in $m^2$ or $ft^2$;
f) Design code or standard used;
g) Shell and head thicknesses; Material specifications for shell and heads;
h) OAL (overall length), OD or ID (outside diameter or inside diameter), HD (head design);
i) Design temperature in °C or °F (min and max);
j) ASME Boiler and Pressure Vessel Code symbol (optional – this is true only if tank is ASME stamped);
k) Date of Hydro static test or Year of manufacture;
l) Product name (propane, butane or LPG);
m) Inspecting authorities' identification if any.

## 4.2 Tank location, spacing and separation distances

**4.2.1** Storage tanks are normally installed aboveground in the open air but they can be buried, underground or mounded. They must never be installed within buildings or in open pits. Storage tanks in bulk plants shall be spaced and located in accordance with Table 2, Table 3 and Table 5.

The distances given are the minimum permitted and referred to the horizontal distance in plan between the tank and the nearest point of a specified feature, e.g. an adjacent storage tank, building, property line, except for underground and mounded tanks where some distances are measured from the Pressure Relief Valves (PRV) or on the manhole cover.

**4.2.2** Separation distances are intended to protect the LPG facilities from the radiation effects of fires involving other facilities as well as to minimize the risk of escaping LPG being ignited before being dispersed or diluted.

**4.2.3** For tank sizes over 265 $m^3$ (70,000 gallons), the separation distances indicated in Table 2 shall not apply to installations built prior to 1978. A hazard and risk analysis shall be conducted in place of Table 2.

**Table 2 – Minimum Separation Distance from tank to important building and/ or source of ignition not associated with the plant, between containers or to a line adjoining property that can be built upon**

| WATER CAPACITY PER CONTAINER (in liters) | Minimum distances (in meters) | | |
|---|---|---|---|
| | Mounded or Underground Containers | Aboveground Containers | Between Containers |
| Less than 500 | 3 | 0 | 0 |
| 500 to 1,000 | 3 | 3 | 0 |
| Above 1,000 to 1,900 | 3 | 3 | 1 |
| Above 1,900 to 7,600 | 3 | 7.6 | 1 |
| Above 7,600 to 11,400 | 15 | 15 | 1.5 |
| Above 11,400 to 26,500 | 15 | 23 | ¼ of sum of diameters of adjacent containers |
| Above 26,500 to 34,100 | 15 | 30 | |
| Above 34,100 to 45,400 | 15 | 38 | |
| Above 45,400 to 75,700 | 15 | 61 | |
| Above 75,700 to 378,500 | 15 | 91 | |
| Above 378,500 | 15 | 122 | |

**4.2.4** Tanks must be installed such that the discharge from the pressure relief valve is at least 15 m (50 ft) horizontally away from any building openings and not less 15 m (50 ft) from any source of ignition or mechanical ventilation air intakes.

**4.2.5** The filling connection and the vent from liquid level gauges shall not be less than 15 m (50 ft) away from any source of ignition or mechanical ventilation air intakes.

**4.2.6** Separation distances for above ground tanks may be reduced by the provision of fire or radiation walls under 4.7, provided a detailed drawings or plans are submitted to and approved by authority having jurisdiction (AHJ).

**4.2.7** The minimum separation distances of aboveground LPG tank to other buildings, structures or points within the Bulk Plant shall be as indicated in Table 3.

**Table 3 – Minimum separation distance from LPG tanks to other points within bulk plants**

| Reference feature | Distance (m) |
|---|---|
| a. Non-controlled areas or buildings, boundary or fixed source of ignition | 15 |
| b. Cylinder Filling Hall | 15 |
| c. Building wall surrounding product tanks of Flammable liquids with flash point up to 65° C | 6 |
| d. Bulk LPG lorry loading/unloading area | 15 |

NOTE See Figure 1.

**4.2.8** The minimum separation distance between an aboveground LPG tank and containers of liquid fuels having flash points below 65° C shall be 6.0 m. No separation distance is required between aboveground LPG tank and underground containers of flammable or combustible liquids.

**4.2.9** No permanent source of heat should be located within 15 m (50 ft) from an LPG storage tank.

**4.2.10** Weeds, long grasses, deciduous shrubs and trees, and any combustible materials shall be removed from the area within the required minimum safety distances.

**4.2.11** The maximum number of tanks in any aboveground group shall be six (6). However, depending on the type of Fire Protection provided this can be increased to nine (9), refer to Table 4. Any one group of tanks shall be separated from any group of tanks by a minimum of 15 m between adjacent vessel shells.

**4.2.12** LPG storage tanks, pumps, compressors, re-filling hall etc. shall not be located directly beneath electrical power cables. For cables carrying less than 1.0 kV the tanks should be sited at least 1.5 m from a line drawn vertically downwards from the power cables. For cables carrying 1.0 kV or greater the distance should be increased to 7.5 m.

**Table 4 – Maximum number of containers in a group and their separation distances**

| Fire protection provided by | Maximum number of containers in one group | Minimum separation between groups | |
|---|---|---|---|
| | | Ft | m |
| Hose streams only (see 0) | 6 | 50 | 15 |
| Fixed monitor nozzles per 12.4.4.5 | 6 | 25 | 7.6 |
| Fixed water spray per 12.4.4.4 | 9 | 25 | 7.6 |
| Insulation per 12.4.4.1 | 9 | 25 | 7.6 |

**4.2.13** Multi-tank installations shall be designed and installed as follows:

a) LPG tanks shall not be installed above or below any other tank such that their outlines overlap when viewed in plan;

b) Precautions must be taken when tanks are interconnected in the liquid phase to ensure that the maximum permissible liquid level in any of the tank is not exceeded or no overfilling shall occur. There should be an isolating valve between adjacent tanks;

c) A vapor equalizing line of adequate size interconnecting all tanks which are interconnected in the liquid phase is essential; and

d) Installation having a liquid return line to the storage tanks, e.g. from pumps, re-filling hall etc. must be designed to avoid overfilling by the inadvertent return of product to tanks otherwise isolated.

**4.2.14** The minimum separation distances between an LPG storage tank and tanks containing oxygen or gaseous hydrogen shall follow Table 5.

**Table 5 – Separation distances of LPG tanks and Oxygen and Hydrogen tanks**

| Separation from oxygen tanks aggregate capacity | | | | | Separation from gaseous hydrogen tanks aggregate capacity | | |
|---|---|---|---|---|---|---|---|
| LPG tanks aggregate water capacity | | | More than 11 $m^3$ * to 566$m^3$* including unconnected reserves | More than 566 $m^3$* including unconnected reserves | | 11 $m^3$* to 85 $m^3$* | More than 85 $m^3$* |
| Gal | $m^3$ | 11 $m^3$ or Less | M | m | Less than 11 $m^3$ | M | m |
| ≤1200 | ≤4.5 | None | 6 | 7.6 | - | - | - |
| >1200 | >4.5 | None | 6 | 15 | - | - | - |
| ≤500 | ≤1.9 | - | - | - | None | 3 | 7.6 |
| >500 | >1.9 | - | - | - | None | 7.6 | 15 |

Cubic meter ($ft^3$) measured at 21°C (70°F) and atmospheric pressure.

**4.2.15 Location of aboveground LPG bulk storage tanks**

**4.2.15.1** Tanks shall be located outside of buildings.

**4.2.15.2** Bulk Storage tank shall be located in accordance with Table 2 with respect to the distance between tanks, the distance between tank and the nearest important building or group of buildings not associated with the LPG plant, or a line of adjoining property that can be built upon.

**4.2.15.3** Multiple above ground tanks (or groups of tanks) installed for use in a single location shall be limited to the number of tanks in one group, with each group separated from the next group in accordance with the degree of fire protection provided in Table 4.

**4.2.15.4** Tanks shall be oriented so that their longitudinal axes do not point toward other containers, aboveground liquefied natural gas tanks, and flammable liquid storage tanks on the same or adjoining property.

**4.2.15.5** No horizontal separation shall be required between aboveground LPG Tanks and underground tanks containing flammable or combustible liquids installed in accordance with NFPA 30, Flammable and Combustible Liquids Code.

**4.2.15.6** LPG Bulk Storage tanks shall not be located within dikes that enclosed flammable liquid tanks and shall not be located within dikes that enclosed refrigerated LPG tanks.

**4.2.15.7** The area under the tanks shall be graded or shall have dikes or curbs installed so that the flow or accumulation of flammable liquids with flash points below 93.4 °C (200 °F) is prevented.

### 4.2.16 Underground LPG bulk storage tanks

**4.2.16.1** Underground tanks shall include buried, partially buried, mounded and semi-mounded tanks.

**4.2.16.2** Tanks shall be located outside of any buildings.

a) Buildings or roadways shall not be constructed over any underground tanks.
b) Sides of adjacent tanks shall be separated by not less than 1 m (3 ft).

**4.2.16.3** The orientation of tanks shall be in accordance with the following:

a) Where tanks are installed parallel with ends in line, any number of tanks shall be permitted to be in one group; and
b) Where more than one row is installed, the adjacent ends of the tanks in each row shall be separated by not less than 3 m (10 ft)

**4.2.16.4** The location of tanks shall be in accordance with the following:

a) Tanks shall be located not less than 15 m (50 ft) from the nearest important building or group of buildings or line of adjacent property that can be built upon;
b) Tanks shall be located not less than 15 m (50 ft) from buildings associated with the utility gas plant; and
c) They shall be located not less than 3 m (10 ft) from flammable liquids storage tanks.

**4.2.16.5** The ground within 7.6 m (25 ft) of any underground tank manholes, domes, nozzles and appurtenances shall be kept clear of ignitable material such as weeds and long, dry grasses.

### 4.2.17 Loading and unloading to and from the bulk tank

**4.2.17.1** Loading means transfer of LPG product from the delivery tank trailer or tank lorry to the stationary bulk storage tank. Loading is also synonymous to "product receiving". Unloading means transfer of LPG product from the stationary Bulk storage tank to the delivery tank trailer or tank lorry. (NOTE: The reference point for this definition is the bulk storage tank.)

4.2.17.2 The use of mobile tank trailer or tank lorry as storage tank is prohibited except on emergency cases or on "temporary basis" only for duration not to exceed one (1) month. If use for emergency or on "temporary basis" only, the tires of trailer or lorry shall be rigidly restraint to prevent the tank from rolling and pulling the pipelines and/or hoses in the event of ground or seismic movement.

**4.2.17.2** Injection of compressed air, oxygen or any oxidizing gas into the tanks to transfer LPG shall be strictly prohibited.

**4.2.17.3** Tank shall be filled only after determination that it complies with the design, materials, construction, testing, inspection, marking and re-qualification requirements and provisions of governing national standards, codes, regulations and/or international accepted code and standards.

**4.2.17.4** Tank shall not be loaded with refrigerated LPG product.

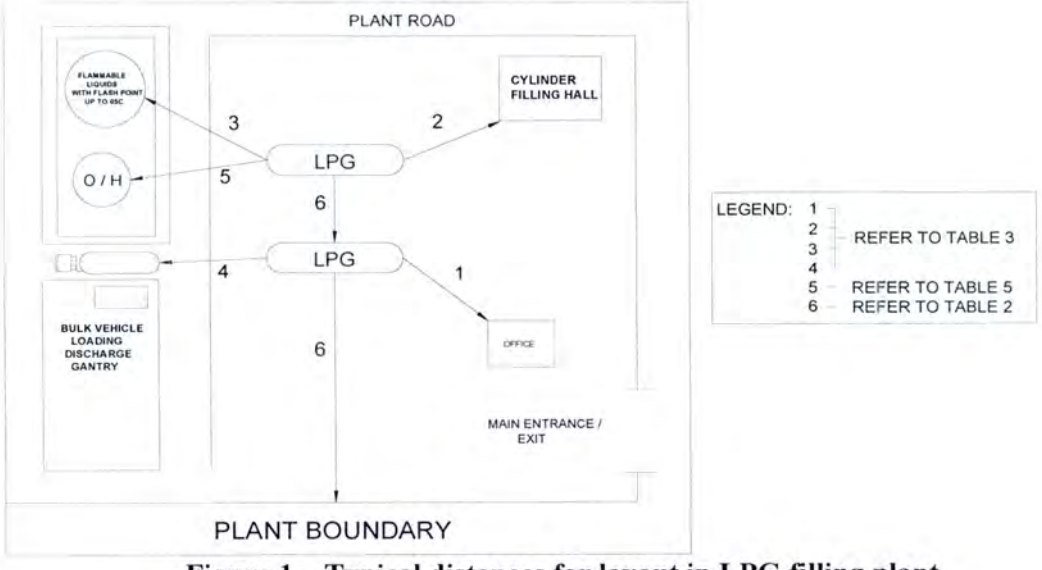


**Figure 1 – Typical distances for layout in LPG filling plant.**

## 4.3 Storage tank area

**4.3.1** Bund walls shall not be constructed around LPG storage tanks since it interfere and impede the vaporization and dispersion of LPG in case of leak.

**4.3.2** Diversion wall with a height not exceeding 380 mm may be required to avoid forming gas traps to direct possible leakage away from tank and source of ignition to a safe area for dispersion.

**4.3.3** The use of continuous wall is not allowed around above ground LPG tanks as this will cause gas trap in the event of leak.

**4.3.4** The ground under the above ground tank shall be graded to have a slight slope to prevent gas from accumulating under the tank in case of leak, but will be directed away from the tank.

**4.3.5** The ground directly under the above ground tank including an area at least 1 m away all around the periphery of tank shall be compacted and if possible concreted. The use of loose soil, grasses, pebbles or gravels under the tank are not recommended since these can accumulate gas under the tank, in case of leak.

**4.3.6** Provision shall be made for handling run-off water during heavy rain and cooling water applied under fire condition or during fire drill exercises.

**4.3.7** The storage tanks shall be separated from the pipe racks or manifold by a separation or deflection wall of at least 0.6 m high and 5 m away from the nearest head or shell of tank.

**4.3.8** No LPG storage tanks should be located within the bounded enclosure of:
a) a tank containing any other flammable liquid,
b) a tank containing liquid oxygen, other hazardous or cryogenic substance,
c) low pressure refrigerated LPG vessel, and
d) any heated storage tank e.g. fuel oil tank.

**4.3.9** To prevent the formation of gas pockets, the vicinity of LPG storage tanks should be free from pits and depressions within the required separation distance.

**4.3.10** Open drains or ducts located within the storage tank safety distance which would permit access and passage of LPG vapors must be fitted with a water trap or otherwise suitably sealed.

**4.3.11 Warning signs and notices**

**4.3.11.1** The tank site shall be provided with suitable warning signs and notices such as:
a) No smoking, No open flame
b) Highly flammable – LPG
c) No entry for unauthorized persons

**4.3.11.2** The signs shall be clearly visible at the applicable safety distance.

**4.3.11.3** For underground / buried or mounded tanks it is recommended that notices are displayed adjacent to the installation to comply with the above requirement.

**4.4 Aboveground tank foundation and supports**

**4.4.1** Tank foundation and support design shall conform to the standard prescribed in PSME Code, Philippine National Building Code, NFPA 58, API 2510 and ASME code.

**4.4.2** Supports shall be constructed solid non-flammable material. If the distance of the bottom of the tank to the ground is greater than 0.5 m, the support must also be constructed of materials that resist deformation when exposed to fire.

**4.4.3** Tank supports and foundation shall be made of one or a combination of the following materials:
a) reinforced masonry;
b) reinforced concrete; and
c) steel plates, pipes or structural shapes.

**4.4.4** The design of the foundation shall be based on a thorough knowledge of the load-bearing capacity and settlement properties of the soil. Where information regarding soil conditions is not available, an actual soil investigation shall be conducted.

**4.4.5** The size and depth of foundation shall be designed to limit settlement of the tank to prevent excessive stresses in the tank and connected piping. Settlement shall be monitored during the hydrostatic test of tank.

**4.4.6** For steel column leg supports shall not be directly attached or welded to the tank base plates but to the pads or doubler plates provided for such attachments. The material for the pads or doubler plates shall be of the same specification as the tank plate. The diagonal members for bracing the column leg supports shall not be directly welded to the tank but to the leg column supports only.

**4.4.7** The steel skirt support for vertical cylindrical tank shall be attached and directly welded to the tank bottom shell course and not to bottom head or end of tank. The steel skirt support material shall be of the same specification as the tank plate.

**4.4.8** Steel column leg supports and skirt support for spherical tank and vertical cylindrical tank respectively shall be designed to be fire-proofed up the shell of the tank.

**4.4.9** Tank supports shall comply with the pressure vessel standard taking into account the tank shell stressing and transmission of the loading to the ground.

**4.4.10** Horizontal cylindrical tank shall have two steel saddle supports only, welded to the shell and designed to accommodate expansion and contraction of the tank i.e. by using fixed and sliding supports. Consideration shall be given to location of steel saddles to obtain the most desirable stress distribution in the vessel shell.

**4.4.11** The shape of saddle supports for horizontal cylindrical tank shall conform to the fabricated shape of the vessel or to the contour of steel doubler pads attached to the tank.

**4.4.12** Tank supports shall be designed to prevent, or drain any accumulation of water and be of sufficient height to allow adequate access for installation, maintenance and use for the bottom fittings.

**4.4.13** Tank supports shall be designed to allow a minimum of 1.5 m clearance between the bottom of the tank shell and the bottom of the finished ground level.

**4.4.14** Every tank shall be supported to prevent the concentration of excessive loads on the supporting portion of the shell or heads.

**4.4.15** For aboveground tank, design of the foundation should take into consideration the following:

a) Ground conditions with special reference to the allowable bearing pressures;
b) The necessity to avoid floatation, if there is a risk of flooding, by securely anchoring, weighting or the use of adequate height;
c) The necessity to avoid settlement particularly differential settlement;
d) Expansion and contraction of the tank shell; and
e) The greatest combined effect incurred by static loading due to the weight of the tank, its contents, water used for hydrostatic test, wind loading, seismic effect, operational loading such as vibration, thermal effects etc.

### 4.4.16 Installation aboveground LPG bulk storage tanks

**4.4.16.1** Provisions to minimize corrosion shall be provided on that portion of the tank that is in contact with the foundations or saddle supports.

**4.4.16.2** Tank shall be kept properly painted or otherwise protected from the elements.

**4.4.16.3** Vertical tank shall be designed to be self-supporting without the use of guy wires and shall take into account wind, seismic forces (earthquake), and hydrostatic test loads.

**4.4.16.4** Design pressure (see **Table 1**) for vertical tank shall be the pressure at the top head with allowance made for increased pressure on the lower shell sections and bottom head due to the static pressure of the product.

**4.4.16.5** Wind loading on containers of 37.9 $m^3$ (10,000 gal) or larger shall be in accordance with the Philippine National Structural Code or Philippine National Building Code.

**4.4.16.6** A seismic design for installations of tanks of 37.9 $m^3$ (10,000 gal) or larger shall be made that meets the approval of the authority having jurisdiction.

**4.4.16.7** If insulation is used, it shall be capable of limiting the tank temperature to not over 427 °C (800 °F) for minimum of 50 minutes, as determined by test with insulation applied to a steel plate and subjected to a test flame substantially over the area of the test plate, and shall be resistant to weathering and the action of hose streams. (See Annex D of NFPA 59)

## 4.5 Tank drainage system

**4.5.1** The drainage system shall be designed, such that it is capable of handling the aggregate quantities of fire water, cooling water and rain water falling in the area without causing flooding of the open trenches.

**4.5.2** The ground to which a bulk storage tank is installed shall be sloped with a minimum slope 1:100 or 1 % grade, to ensure that escaped product has preferential flow away from the vessel and cannot accumulate under the tank.

**4.5.3** The slope shall be away from the piping manifold or other important areas or processing units.

**4.5.4** The ground below the tank or within the 5 m of the periphery of the vessel or group of vessels shall be smooth, well compacted and be free from any vegetation or debris.

**4.5.5** Bituminous materials shall not be used for paving the ground under the tank or in its periphery

### 4.5.6 Drain connection

**4.5.6.1** Drain connections shall be provided with a shut-off valve preferably not more than 50 mm nominal diameter.

**4.5.6.2** The outlet of the drain valves shall be provided with a length of piping terminating with a second shut-off valve. The length of piping should be such that the risk of

simultaneous obstruction of the two valves, e.g. by freezing of any accumulated water, is minimized.

**4.5.6.3** The additional pipe work and second valve may be fitted at time of draining provided that the fixed drain valve is protected by an excess flow valve fitted upstream.

**4.5.6.4** The outlet of the drain valve system should be blank-flanged, plugged or otherwise secured against tampering or accidental opening when not in use.

**4.5.6.5** No drain shall discharge into or be in the proximity of any drainage system.

### 4.6 Installation of underground / buried tanks

**4.6.1** Underground / buried tanks shall be set on firm foundations and shall be securely restrained against flotation. The back fill material should be free of rocks or other abrasive material and should be carefully compacted. It is recommended that not less than 0.3 m (1 ft) of cover should be provided, if top of tank is free of vehicle traffic. However if with vehicle traffic, it shall have a top cover not less than 1 m (3.28 feet).

**4.6.2** Tank fittings and appurtenances shall be accessible for operation or repair without disturbing the mounding materials.

**4.6.3** Underground / buried tanks shall be provided with appropriate anchoring devices to avoid flotation in case tank will be submerged under water.

**4.6.4** Underground / buried tank shall be protected from superimposed aboveground loading, e.g. due to vehicular traffic or other cause, either by fencing off the area under which tanks are buried or protecting them with a reinforced concrete slab or other adequate cover. If the tank area is not fenced off, the tank manhole cover and the tank fittings should be protected against damage and tampering.

**4.6.5** Underground/ buried tank shall be protected against corrosion by application of suitable paint coatings or anti-corrosion wrappings and anti-corrosion cathodic protection (like sacrificial anodes or impressed current cathodic protection).

**4.6.6** All connections shall be in the container manway or at openings along the top length of the container. Bottom connections to the container shall be prohibited, except as permitted in 4.6.9.5.

**4.6.7** Bulk storage tank assemblies listed for underground installation, including inter-changeable aboveground-underground tank assemblies, shall be installed underground in accordance with the following:

a) Protection shall be provided for the fitting housing, housing cover, tank connections and piping against any physical damage and adverse effect of exposure to weather.
b) Where the tanks are installed underground within 3 m (10 ft) of where vehicular traffic can be expected, protection against vehicular damage shall be provided for the fitting housing, housing cover, tank connections and piping.
c) Any party involved in the construction or excavation in the vicinity of a buried tank shall be responsible for determining the location of, and providing protection for, the tank and piping against their physical damage from vehicular traffic.

d) Where a tank is to be abandoned, the procedure and rules of the DENR shall be followed.
e) The discharge of the regulatory vent shall be above the highest probable water level and at least 3.0 m from the ground.
f) All metallic equipments and components that are underground/buried shall be coated or protected and maintained to prevent corrosion.
g) Corrosion protection of all other materials shall be in accordance with accepted engineering practices.
h) Any damage to the coating shall be repaired before backfilling.
i) Tanks shall be set level and shall be surrounded by earth or sand firmly tamped in place.

### 4.6.8 Installation of mounded tanks

**4.6.8.1** Mounded tank shall be regarded as an underground tank for the purpose of separation distances, provided it has at least 0.3 m (1 ft) of cover on top of the tank shell.

**4.6.8.2** Mounding material shall be earth, sand, or other non-combustible, non-corrosive materials and shall provide a minimum thickness of cover for the tank of at least 0.30 m (1 ft.) on top of the tank shell.

**4.6.8.3** A protective cover shall be provided on top of mounding materials subject to erosion.

**4.6.8.4** The cover over mounded tank shall be stable under all weather conditions. Where any exposed surfaces are protected by fixed water sprays the mounding shall be protected against possible erosion during testing.

**4.6.8.5** Tank valves and appurtenances shall be accessible for operation or repair, without disturbing mounding material, as follows:
a) Where tanks are mounded and the bottom of the tank is 0.76 m (30 in.) or more above the surrounding grade, access to bottom connections shall be provided by an opening or tunnel with a 1.2 m (4 ft.) minimum diameter and a 0.9 m (3 ft.) minimum clear area.
b) Bottom connections that extend beyond the mound shall be part of the tank or shall be installed in compliance with the ASME Code and shall be designed for the forces that can act on the connections.

**4.6.8.6** Mounded tank shall be coated and protected from corrosion. Mounded tank shall be protected against corrosion by application of suitable paint coatings or anti-corrosion wrappings and anti-corrosion cathodic protection (like sacrificial anodes or impressed current cathodic protection).

**4.6.8.7** All tank metallic components and structures that are underground or buried shall be coated or protected and maintained to minimize corrosion.

**4.6.8.8** Corrosion protection of all other materials shall be in accordance with accepted engineering practices.

### 4.6.9 Filling densities

**4.6.9.1** Pressurized LPG tank shall be filled in accordance with the following formula:

$$V = D / G \times F$$

where

$V$ is the maximum liquid volume (in percentage of total container capacity) at temperature $T$,
$D$ is the filling density from Table 6 in percentage,
$G$ is the specific gravity of LPG at 15.6°C (60°F) to be placed in the tank,
$F$ is the correction factor for correcting liquid volume from 15.6°C (60°F) to volume at temperature $T$ *(For F values, see Table B.2. of NFPA 59)*, and
$T$ is the temperature of liquid LPG in the tank (in degrees Fahrenheit).

**4.6.9.2** Filling densities of underground non-refrigerated tanks shall be in accordance with Table 6.

**Table 6 – Maximum permitted filling density**

| Aboveground tanks | | | |
|---|---|---|---|
| Specific gravity at 60°F (15.6°C) | 0 to 1200 U.S. gal (1000 imperial gal, 4.5 $m^3$) total water capacity (%) | Over 1200 U.S.gal (1000 imperial gal, 4.5$m^3$) total water capacity (%) | Underground tanks, all capacities (%) |
| 0.496–0.503 | 41 | 44 | 45 |
| 0.504–0.510 | 42 | 45 | 46 |
| 0.511–0.519 | 43 | 46 | 47 |
| 0.520–0.527 | 44 | 47 | 48 |
| 0.528–0.536 | 45 | 48 | 49 |
| 0.537–0.544 | 46 | 49 | 50 |
| 0.545–0.552 | 47 | 50 | 51 |
| 0.553–0.560 | 48 | 51 | 52 |
| 0.561–0.568 | 49 | 52 | 53 |
| 0.569–0.576 | 50 | 53 | 54 |
| 0.577–0.584 | 51 | 54 | 55 |
| 0.585–0.592 | 52 | 55 | 56 |
| 0.593–0.600 | 53 | 56 | 57 |

**4.6.9.3** Where the maximum ground temperatures do not exceed 15.6° C (60° F), the filling density shall be based on Table 6 or on accepted engineering practices for the operating conditions involved with the approval of the authority having jurisdiction.

## 4.7 Firewall for aboveground tank

**4.7.1** Fire or radiation walls may permit separation distances to be reduced. They should be of such length that the distance from the tank to a boundary or fixed ignition source measured around the end of the wall is not less than the required safety distances of Tables 2 and 3. Tanks shall not be located less than 1.5 m from the firewall. See Figure 2.

**4.7.2** Firewall must be solid, without openings, and constructed from brick, concrete or suitable non-combustible material shall not be less than 3 m (10 ft) high or the height of the tank including its pressure relief valves and pipe-away adaptors, whichever is higher.

**4.7.3** Not more than two radiation walls should be provided for any storage tank and the remaining two sides should be such that the natural ventilation is not significantly impaired.

**4.7.4** A firewall may be built on a boundary but in such cases it must be wholly under the control of the occupier of the LPG storage plant.

**4.7.4.1** There should be no openings in the wall either on the sides or on top of the storage tank.

**4.7.4.2** There should be no overhanging eaves or similar projections constructed from combustible materials immediately above any storage tank. No external stairway or fire escape should be positioned above a storage tanks or be allowed to terminate in the storage area.

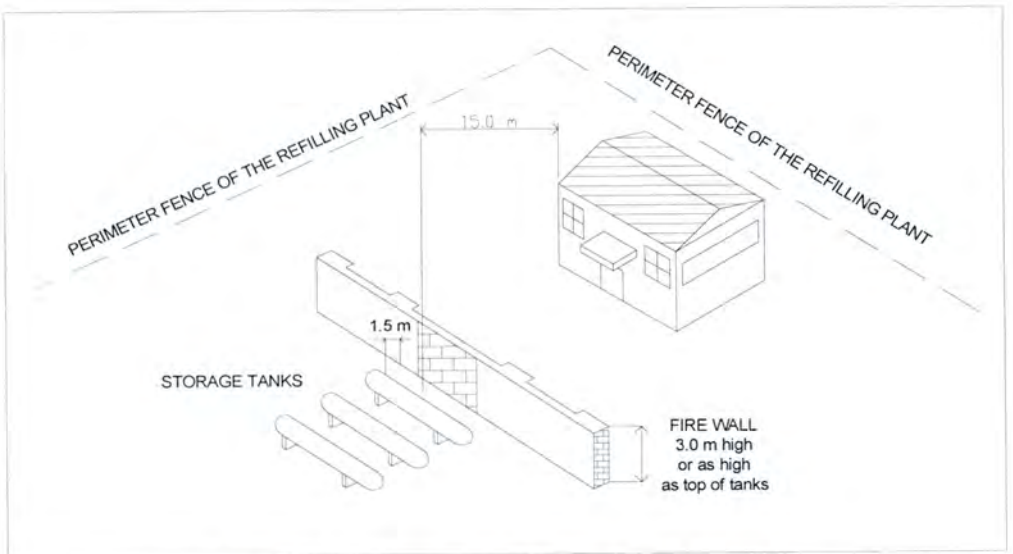


**Figure 2 – Separation distance with firewall**

## 4.8 Tank nozzles, connections and appurtenances

**4.8.1** LPG tanks shall be provided with at least one each of the following:

a) Pressure relief device situated at the vapor portion of the vessel;
b) Fixed maximum liquid level device or equivalent high-level alarm;
c) Liquid level gauge or indicator;
d) Pressure gauge;
e) Drains or other means of removing liquid contents;
f) Filling connection;
g) Service connection; and
h) Temperature gauge for liquid and vapor are optional.

**4.8.2** All fittings installed on the tank shall be suitable for LPG service over the range of temperatures and pressures that the product will reach in service.

**4.8.3** Labels or appropriate markings shall be required and maintained in safety valves, liquid level gauging devices, and pressure gauges.

**4.8.4** Tanks with internal diameter of 1,700 mm or greater shall be provided with manholes for internal inspection. The minimum size of the manhole shall be 458 mm (18 in).

**4.8.5** All flanges shall be ANSI B 16.5 Class 300 or rated 300 lbs. All coupling connections shall be limited to 1-1/2 inch diameter, either half or full shall be low carbon steel rated 3000 lbs.

**4.8.6** Spiral wound graphite filled stainless steel gaskets or metallic gaskets shall be used for flanged connections. Compressed asbestos gasket shall not be used.

### 4.8.7 Shut-off and emergency valves

**4.8.7.1** All shutoff valves and accessory equipment (liquid or gas) shall be compatible with LPG and designed for not less than the maximum extreme pressure and temperature to which they can be subjected.

a) Valves for use with pressurized bulk tanks that can be subjected to tank pressure shall have a rated working pressure of at least 1.7 MPa (250 psi).
b) Cast-iron valves, piping, and fittings shall be prohibited on LPG tanks and their connections except for tank valves or fittings that are made of malleable or nodular iron.

**4.8.7.2** All connections to tanks shall have shutoff valves located as close to tank as practical.

a) Valves shall be accessible for operation and maintenance under normal and emergency conditions, either by location or by means of permanently installed special provisions.

b) Valves installed in unobstructed locations that are not more than 1.5 m (5 ft) above ground level shall be considered accessible.

c) Stairs, ladders, platforms, remote operators, extension handles, etc., shall be installed where valves are located 1.5 m (5 ft) or more above ground level.

d) Safety relief connections, liquid level gauging devices, and plugged openings shall be required to be accessible.

**4.8.7.3** All liquid and vapor connections on tanks, other than pressure relief valves, liquid level gauging devices, and openings not larger than 1.4 mm or 0.055 in (No. 54 drill size) shall be equipped with one of the following:

a) A back-pressure check valve and either a manual valve or a remote-operated emergency shutoff valve;
b) The remote-operated emergency shutdown valve must be equipped with automatic shutoff using thermal (fire) actuation where the thermal element is located within 1.5 m (5 ft) of the valve; and
c) A quick-acting internal valve incorporating the means of closing specified in 6.1.4.

### 4.8.8 Excess flow valves

**4.8.8.1** The flow rate for closure of excess valve should be less than that likely to result from complete fracture of the line it is protecting but should prevent premature closing by sizing flow rate substantially above the normal design flow rate.

**4.8.8.2** The connections or lines, including valves, fittings, and so forth, downstream of an excess-flow valve shall have a greater capacity than the rated flow of the excess-flow valve.

**4.8.8.3** Openings from a tank or through fittings attached directly on the tank to which pressure gauge connection is made shall not be required to be equipped with an excess flow valve if such openings are not larger than 1.4mm or 0.055 in (No. 54 drill size).

**4.8.8.4** Excess-flow and backpressure check valves, where required by this standard, shall be located inside the tank or at a point outside where the line enters the tank. In the latter case, installation shall be made in such a manner that any stress beyond the excess-flow or backpressure check valve will not cause breakage between the container and such valve.

**4.8.8.5** Excess-flow valves shall be designed with a bypass, not to exceed 1.01 mm or 0.04 in (No. 60 drill size) opening, to allow equalization of pressures.

**4.8.9 Fixed maximum liquid level device (Level protective functions and alarm)**

**4.8.9.1** The device shall be of a type that allows vapor or liquid to bleed from a valve attached to a dip-tube to indicate when the maximum permitted level is reached during filling.

**4.8.9.2** The computed length of the dip tube shall be determined based on the recommended maximum liquid level of 90 %.

**4.8.9.3** The connection through the tank shall not be larger than 1.4 mm diameter unless fitted with an excess flow valve and shall be installed so that it is visible from the filling point.

**4.8.10 Filling connections**

**4.8.10.1** Remote filling connections shall terminate with a manual shut-off valve and transfer hose half coupling protected immediately upstream of the valve as appropriate.

**4.8.10.2** Transfer hoses shall be made of LPG resistant material and if steel wire braiding or steel wire reinforcement is used, it shall be of stainless steel. Hoses shall have electrical continuity between end couplings.

**4.8.10.3** Filling connections are recommended to be fitted with internal spray pipes or used with vapor equalizing lines for pressure equalization between the delivery tanker and the storage tank during delivery.

**4.8.11 Pressure gauge**

All tanks should be equipped with a suitable pressure gauge connected to the vapor space of the tank. Pressure gauge connection hole to the tank shall preferably not be larger than 1.4 mm diameter and shall be protected by a suitable shut-off valve.

**4.8.12 Contents gauge**

**4.8.12.1** All contents gauges should clearly indicate whether they read in % of water capacity or fractional LPG capacity, or actual contents in gallons, tons etc.

**4.8.12.2** Any gauging device that relies on bleeding to atmosphere, such as a rotary tube, fixed tube or slip tube, shall be such that:

a) The bleed hole maximum opening is not larger than 1.4 mm diameter unless it is protected by an excess flow valve.
b) It cannot be completely withdrawn in normal gauging operations.
c) The gland is capable of being repacked without withdrawing the vessel from service.

**4.8.12.3** Each pressurized LPG bulk storage system shall be equipped with an approved liquid level gauging device in accordance with the following:

a) If the liquid level-gauging device is a float type or a pressure differential type, the container also shall be provided with an auxiliary gauging device, such as a fixed dip tube, slip tube, rotary gauge, or similar device; and
b) Unlisted gauge glasses of the columnar type shall not be permitted.

**4.8.12.4** All gauging devices shall be arranged so that the maximum liquid level to which the container can be filled for butane, for a 50-50 mixture of butane and propane, and for propane is determinable.

**4.8.12.5** Gauging devices that require bleeding of the product to the atmosphere, such as the rotary tube, fixed tube, and slip tube, shall be designed so that the bleed valve maximum opening is not larger than 1.4 mm or 0.055 in. (No. 54 drill size) unless provided with an excess-flow valve.

**4.8.12.6** Gauging devices for tanks shall have a maximum allowable working pressure at least equal to that of the tanks to which they are attached.

**4.8.12.7** Where used, the length of a fixed tube device shall be designed to indicate the maximum level to which the container can be filled for the product contained, based on the volume of the product at 4.4 °C (40 °F) at its maximum permitted filling density for aboveground tanks and at 10 °C (50 °F) for buried tanks.

### 4.8.13 Temperature gauge

**4.8.13.1** Temperature gauge when fitted shall be installed in suitable thermowell.

**4.8.13.2** The thermowells shall be in the form of blind tubes of suitable length and strength, oil filled, permanently welded to the tank and constructed in accordance with the tank design Code.

### 4.8.14 LPG pumps and compressors

**4.8.14.1** Pumps, compressors, etc. used shall be made of materials suitable to the grade of LPG and the range of temperatures and pressures the product will reach in service. Cast iron shall not be used unless they have adequate ductility and resistance to brittle fracture. Ductile iron with an elongation at fracture of not less than 18 % is acceptable.

**4.8.14.2** Positive displacement pumps must have a by-pass or other suitable protection system against excessive pressure.

**4.8.14.3** Pumps should also be protected by suitable strainers/filter devices.

**4.8.14.4** Mechanical seals are preferable to packed glands.

**4.8.14.5** Electric motors and other electrical equipment must be suitable for use in areas as classified in Table 12. Belt drives shall be anti-static type.

**4.8.14.6** Where remote starters are installed, a flame-proof means of isolation with lockout should be fitted adjacent to the pump motor to facilitate servicing.

**4.8.14.7** Pumps, compressors and their motors should be protected against accidental damage and the weather by suitable positioning and/or protection. They should not be sited beneath the tanks.

**4.8.14.8** Any electrical equipment must be sited in accordance with the area classification shown in Table 12.

**4.8.14.9** The location of pumps should be selected to minimize the risk of cavitation under the specified operating conditions.

**4.8.14.10** Pumps should be located to facilitate ease of maintenance.

**4.8.14.11** Each pump and compressor shall be recommended by the manufacturer for the LPG service intended.

**4.8.14.12** Each pump and compressor shall be marked with its maximum working pressure.

**4.8.15 Hose specifications for pressurized LPG**

**4.8.15.1** Hose assemblies shall be observed for leakage or for damage that could impair the integrity before each use.

**4.8.15.2** Hose shall be fabricated of materials that are resistant to the action of LPG and shall be approved.

**4.8.15.3** Hose, hose connections, and flexible connections shall comply with the following:

a) Hose shall be designed for a minimum bursting pressure of 12.1 MPa (1750 psi) [2.41 MPa (350 psi)] working pressure] and shall be marked with "LPG," with the working pressure in psi marked at not greater than 3m (10ft) intervals; and
b) Hose assemblies, after the application of connections, shall have a design capability of withstanding a pressure of not less than 4.83 MPa (700 psi).

**4.8.15.4** Hose assemblies shall be inspected at least once a year.

**4.8.15.5** Inspection of pressurized hose assemblies shall include the following:

a) Damage to outer cover that exposes reinforcement;
b) Kinked or flattened hose;
c) Soft spots or bulges in hose;
d) Couplings that have slipped on the hose, are damaged, have missing parts or have loosed bolts; and
e) Leakage.

**4.8.15.6** Hose assemblies shall be replaced, repaired or continued in service based on the results of this inspection.

**4.8.15.7** Leaking or damaged hose shall be immediately repaired, removed from service or replaced.

## 4.9 Tank re-qualification, testing and purging

### 4.9.1 General requirements

**4.9.1.1** The testing, re-qualification, purging and commissioning of the plant should be a responsibility undertaken only by trained and competent personnel and in accordance with manufacturer's instructions where applicable.

**4.9.1.2** The following Codes and Standards in accordance with their latest revisions shall be adopted for purposes of inspection, checking, testing and other considerations prior to the approval for installation and use of LPG tanks:

a) ASME Codes;
b) PSME. Code;
c) DOLE – BWC Occupational Safety and Health Standards
d) PLPGA Safety Code

**4.9.1.3** Tanks under the following conditions shall be inspected externally and internally, before being placed into service by authorized and qualified engineers:

a) after installation;
b) after repairs;
c) after it has contained materials other than LPG;
d) after it has been reinstalled in other location;
e) after it has been exposed to fire;
f) because of marked damage due to handling and other exposures; and
g) at periodic intervals required by competent authority depending upon the nature of operation and conditions of the tanks.

**4.9.1.4** The manufacturer's certificate and the records of inspection shall be kept and made available for examination during the operating life of the tank.

**4.9.1.5** Inspection of tanks shall consist of any or a combination of the following tests:
a) visual examination
b) tests for gas leaks;
c) ultrasonic thickness tests;
d) magnetic particle tests.
e) radiographic tests; and
f) hydrostatic test when considered necessary by the competent authority

**4.9.1.6** When tanks are subjected to hydrostatic test, the required test pressure shall not be less than one and one-half (1½) times its design pressure or maximum allowable working pressure (for tanks manufactured before 2000 based on ASME Code) and one and one-fourth (1¼) times its design pressure or maximum allowable working pressure (for tanks manufactured after 2000 based on ASME Code).

### 4.9.2 Requalification and maintenance

**4.9.2.1** Major examinations of LPG storage tanks shall be carried out by a trained and competent person and the name plate marked with the following:

a) month and year of the date of examination, e.g. 09/05;
b) test pressure in BarG, kg/cm$^2$, MPaG; and
c) entity that conducted the examination.

**4.9.2.2** Tank records for above ground installations should distinguish between 5-year visual external inspection and 10 year examinations. Examinations must be carried out before the end of the fifth or tenth year (as appropriate), following the year of the previous examination and scope.

**4.9.2.3** Above ground installation (5) year examination

a) Identify tank by name plate/tank markings or stampings.
b) Visual examination of external surfaces and all welds for signs of defects and if necessary by NDT methods.
c) Carry out examination of fittings.
d) Check that tank relief valves have been replaced in accordance with 9.1.4. The pressure relief valves should satisfy the design requirements of the tanks in terms of set pressure and capacity.
e) After satisfactory examination ensure that the date, test pressure and entity that conducted examination is marked on name plate.
f) Issue report.

**4.9.2.4** Above ground installation 10 year examination

a) Carry out stages as listed in five-year examination in 4.9.2.3.
b) Carry out wall thickness checks or hydrostatic test or internal examination.
c) After satisfactory examination, ensure the date, test pressure and entity that conducted the examination is marked on nameplate.
d) Issue report.

**4.9.2.5** Underground/Mounded Installation every 5 year examination

a) Identify tank by nameplate markings or stampings.
b) Full internal visual examination and wall thickness check or hydrostatic test. (Where internal examination is not practical the outside surfaces of the tank shall be exposed for examination or as directed by the trained and competent person).
c) Check that fittings are in order.
d) Check that pressure relief valves have been replaced in accordance with 9.1.4. The pressure relief valve should satisfy the design requirements of the tank in terms of set pressure and capacity.
e) After satisfactory examination, ensure the date, test pressure or permissible working pressure and entity that conducted the examination is marked on nameplate.
f) Issue report.

### 4.9.3 Leak testing – Tanks and fittings

**4.9.3.1** Tanks and associated fittings shall be leak tested prior to filling. The leak test pressure shall not be less than 6 bars gauge but no more than 90 percent of the tank design pressure.

**4.9.3.2** The test medium can either be inert gas or water. Using inert gas, pressurize tank and associated fittings and check with soap solution for signs of leakage. For water, fill tank completely and pressurize. Check to ensure zero pressure drop or no leak or deformation over a period of not less than 1 hour.

**4.9.3.3** Other tank fittings shall be inspected and tested simultaneously with the internal inspection or hydrostatic testing of the tank, at interval not exceeding five years.

**4.9.3.4** All piping systems, including their associate fittings and equipment, shall be tested before being taken into service at a pressure not less than 1.5 times their maximum service pressure.

### 4.9.4 Purging

**4.9.4.1** All tanks and associated fittings should be purged until there is insufficient oxygen inside to support combustion. To do so, the air should be either evacuated or replaced with inert gas, water or LPG.

**4.9.4.2** If inert gas is used, this needs to be removed from the tank with LPG, taking care to direct the purged gas away from ignition sources, boundaries, buildings or public places or to a flare stack. Care should be taken during purging to ensure the safe dispersion of unignited purge gases. If purge gases are flared, this should be outside the normal separation distances.

**4.9.4.3** When LPG vapor is used to replace air, the tank and fittings will for a period of time contain a flammable mixture. A competent or trained person should conduct the venting to atmosphere in a safe manner. A flame arrestor must be fitted in the vent line to prevent flashback should the LPG/air mixture ignite.

**4.9.4.4** If using water as a purge medium, check before starting that the tank and its support will be capable of holding the full weight of water. After purging, ensure that all the water is removed from the tank.

### 4.9.5 Initial fill

A trained and competent person should be present and in control throughout the initial fill. Care should be taken to limit flash vaporization on initial fill. This can be achieved by pressurizing the tank with vapor before introducing liquid LPG. During initial fill, any inert gas shall be safely vented from the vessel.

### 4.9.6 Unidentified tank (Above, underground and mounded) Detailed examination

**4.9.6.1** From information available and the checks listed below, an appropriate Standard/Code/Class can be established.

**4.9.6.2** Confirm suitable materials have been used in the fabrication of the tank. This may involve chemical analysis of parent and weld materials and hardness tests.

**4.9.6.3** Carry out full dimensional check. Design calculations to satisfy the design requirements of this Code should be carried out on the tank and metallic legs or saddles permanently attached to it.

**4.9.6.4** Carry out visual examination of external and internal (where possible) surfaces and all welds for signs of defects. Where considered necessary, defects can be assessed by NDT methods.

**4.9.6.5** An ultrasonic / radiographic check on 10 % of the main seams including all the 'T' junctions. (Ultrasonic from inside preferred in the case of these tanks).

**4.9.6.6** Carry out hydrostatic test.

**4.9.6.7** Ensure that all essential fittings are provided.

**4.9.6.8** Check that all fittings are in order and that:

a) The pressure relief valves satisfy the design requirements of the tank in terms of set pressure and capacity.
b) The fixed liquid level gauge is set for the maximum fill capacity appropriate for the service intended.
   i. Attach a data plate containing the information details.
   ii. Issue report.

## 5 Cylinder refilling facility

This clause applies to transfer of LPG from one container to another wherever this transfer involves connections and disconnections in the transfer system or the venting of LPG to the atmosphere.

This also applies to operational safety and method for determining the quantity of LPG permitted in containers.

### 5.1 Operational safety

#### 5.1.1 Transfer personnel

**5.1.1.1** Transfer operations shall be conducted by trained and company authorized personnel meeting the provision of Annex A.

**5.1.1.2** At least one trained and company authorized personnel shall remain in attendance at the transfer operation from the time connections are made until the transfer is completed, shutoff valves are closed, and lines are disconnected.

**5.1.1.3** Transfer personnel shall exercise precaution to ensure that the LPG transferred are those for which the transfer system and the containers to be filled are designed.

### 5.2 Filling and evacuating containers

**5.2.1** Transfer of LPG to and from a container shall be accomplished only by qualified persons trained in proper handling and operating procedures meeting the requirements of Annex A and in emergency response procedures.

**5.2.2** Injection of compressed air, oxygen, or any oxidizing gas into containers to transfer LPG shall be prohibited.

**5.2.3** When evacuating a container owned by others, the trained and company authorized person(s) performing the transfer shall not inject any material other than LPG into the container.

**5.2.4** Valve outlets on cylinders shall be equipped with an effective seal such as a plug, cap, listed, quick-closing coupling, or a listed quick-connect coupling.

**5.2.5** Valve outlet seals and security seals shall be in place whenever the cylinder is not connected for use.

**5.2.6** New unused cylinders (not filled with LPG) shall not be required to be equipped with valve outlet seals.

**5.2.7** Cylinders shall be filled only after determination that they comply with the design, fabrication, inspection, marking and requalification provisions of PNS 03-1:2000 (LPG Steel Cylinder – Specification) and PNS 03-2:2000 (LPG Steel Cylinders – Methods of Re-qualification).

**5.2.8** "Single trip," "nonrefillable," or "disposable" canisters shall not be refilled.

**5.2.9** The service pressure of the cylinder shall not exceed 80% of the design pressure.

**5.2.10** A cylinder shall not be filled if the container assembly does not meet the requirements for continued service as provided in the (section in the PNS 03-2:2014).

**5.2.11** Transfer hoses larger than 12 mm (1/2 in) internal diameter shall not be used for making connection to individual cylinders being filled indoors.

### 5.3 Purging of new and re-qualified cylinders

**5.3.1** Venting of gas from containers for purging or for other purposes shall be accomplished in accordance with 5.3.2 through 5.3.4.

**5.3.2** Venting of cylinder indoors shall only occur in structures designed and constructed for cylinder filling in accordance with 6.4 of the NFPA 58 (Location of Transfer Operations) and Chapter 10 of the NFPA 58 (Building or Structures Housing LP-Gas Distribution Facilities) and with the following:

a) Piping shall be installed to convey the vented product outdoors at least 1m (3 ft) above the highest point of any building within 7.6 m (25 ft);
b) Only vapors shall be exhausted to the atmosphere; and
c) If a vent manifold is used to allow for the venting of more than one cylinder at a time, each connection to the vent manifold shall be equipped with a back flow check valve.

**5.3.3** Venting of tanks outdoors shall be performed under conditions that result in rapid dispersion of the product being released.

**5.3.4** If conditions are such that venting into the atmosphere cannot be accomplished safely, LPG shall be burned at least a distance of 7.6 m (25 ft) from combustibles.

### 5.4 Venting of LPG to the atmosphere

LPG in liquid or vapor form shall not be vented to atmosphere except under the following conditions:

**5.4.1** Venting of LPG shall be permitted from fixed liquid level, rotary and slip tube gauges, with hole or orifice not exceeding 4 mm (No. 54 drill size orifice);

**5.4.2** Venting of LPG between shut-off valves before disconnecting the liquid transfer line from the tank to the vehicle shall be permitted;

**5.4.3** Venting of LPG, where necessary shall be permitted to be performed by the use of bleeder valves; and

**5.4.4** Venting of LPG listed LPG liquid transfer pumps using such vapor as a source of energy shall be permitted where the rate of discharge does not exceed the discharge from the orifice of 3.05 mm (No. 31 drill size orifice).

### 5.5 Quantity of LPG in containers

Clause 5.3 applies to the maximum permissible LPG content of containers and the methods of verifying this quantity.

### 5.6 LPG capacity of containers

**5.6.1** The capacity of an LPG container shall be determined either by weight in accordance with 5.6.2.

**5.6.2** The maximum filling limit by weight of LPG in a container shall be in accordance with Table 7.

**Table 7 – Maximum filling limit by weight of LPG containers (Percent of marked water capacity in lbs)**

| | Aboveground Containers | | |
|---|---|---|---|
| Specific gravity at 60 °F (15.6 °C) | 0 to 4.5 $m^3$ (0 to 1200 U.S. gal) total water capacities, % | Over 4.5 m3 (over 1200 U.S. gal) total water capacities, % | Underground containers all capacities, % |
| 0.496 – 0.503 | 41 | 44 | 45 |
| 0.504 – 0.510 | 42 | 45 | 46 |
| 0.511 – 0.519 | 43 | 46 | 47 |
| 0.520 – 0.527 | 44 | 47 | 48 |
| 0.528 – 0.536 | 45 | 48 | 49 |
| 0.537 – 0.544 | 46 | 49 | 50 |
| 0.545 – 0.552 | 47 | 50 | 51 |
| 0.553 – 0.560 | 48 | 51 | 52 |
| 0.561 – 0.568 | 49 | 52 | 53 |
| 0.569 – 0.576 | 50 | 53 | 54 |

| | | | |
|---|---|---|---|
| 0.577 – 0.584 | 51 | 54 | 55 |
| 0.585 – 0.592 | 52 | 55 | 56 |
| 0.593 – 0.600 | 53 | 56 | 57 |

## 5.7 Overfilling

**5.7.1** An overfilling prevention device shall not be the primary means to determine when a cylinder is filled to the maximum allowable filling limit.

**Table 8 – Distance between point of transfer and exposures**

| Part | Exposure | Minimum horizontal distance | |
|---|---|---|---|
| | | Ft | M |
| A | Buildings[a] with fire-resistive walls | 10[c] | 3.1 |
| B | Buildings[a] with other than fire-resistive walls[b] | 25[c] | 7.6[c] |
| C | Building wall openings or pits at or below the level of the point of transfer | 25[c] | 7.6[c] |
| D | Line of adjoining property that can be built upon | 25[c] | 7.6[c] |
| E | Outdoor places of public assembly including schoolyards, athletic fields and playgrounds | 50[c] | 15[c] |
| F | Public ways including public streets, highways, thoroughfares and sidewalks | | |
| | (1) From points of transfer in LPG dispensing stations and at vehicle fuel dispensers | 10 | 3.1 |
| | (2) From other points of transfer | 25c | 7.6c |
| G | Driveways[d] | 5 | 1.5 |
| H | Mainline railroad track centerlines | 25 | 7.6 |
| I | Containers[e] other than those being filled | 10 | 3.1 |
| J | Flammable and Class II combustible liquid[f] dispensers and the fill connections of containers | 10[c] | 3.1[c] |
| K | Flammable and Class II combustible liquid containers, aboveground containers and containers underground | 20 | 6.1 |

a. Buildings for the purpose of the table also include structures such as tents and box trailers at construction sites.

b. Walls constructed of noncombustible materials having as erected, a fire resistance rating at least 1 hour as determined by NFPA 251, *Standard Method of Tests of Fire Endurance of Building Construction and Materials.*

c. See 6.5.4.4 of NFPA 58

d. Not applicable to driveways and points of transfer at vehicle fuel dispensers.

e. Not applicable to filling connections at the storage container or to dispensing vehicle fuel dispenser units of 7.6m$^3$ (2000 gal) water capacity or less when used for filling containers not mounted on vehicles.

f. NFPA 30, Flammable and Combustible Liquids Code, defines these as follows: Flammable liquids include those having a flash point below 37.8 °C (100 °F) and having a vapor pressure not exceeding 40 psia (an absolute pressure of 2068 mm Hg) at 37.8 °C

(100 °F). Class II combustible liquids include those having a flash point at or above 37.8 °C (100 °F) and below 60 °C (140 °F).

## 5.8 Storage area (Filled and empty cylinders)

This clause shall be applicable to storage of LPG cylinders, whether filled, partially filled, or empty awaiting resale. It does not apply to storage of cylinders at commercial establishment/retail/dealer outlets.

### 5.8.1 General requirements

**5.8.1.1** LPG cylinders should preferably be stored in a well-ventilated, open air and at ground level location. Where this is not practicable, storage inside buildings may be allowed provided the requirements of 5.10 are met. Any LPG storage area must be readily accessible to facilitate quick removal.

**5.8.1.2** The storage area should be protected by an adequate security fence. Access of vehicles and mechanical handling equipment into the storage area must be strictly controlled to prevent collision with cylinders.

**5.8.1.3** Refillable LPG cylinders are considered filled whatever the state of their contents, except where adequate provision can be made to ensure that fully filled cylinders are stored separately from nominally empty cylinders.

**5.8.1.4** Whether LPG cylinders are filled or nominally empty they should be stored with valves upright. Valves of both filled and empty cylinders should always be closed while in storage.

**5.8.1.5** All weeds, long grass and any combustible materials should be removed from the area within the separation distances set out in Table 9 up to a maximum of 3 m from the nearest stacks of cylinders.

**5.8.1.6** Hazardous products such as flammable liquids combustible, explosive, corrosive, oxidizing or toxic materials, compressed gases and oxygen cylinders etc. should not be stored within the LPG area or separation distances.

### 5.8.2 Open air storage

**5.8.2.1** Open-air storage or any open loading platform may be provided with a roof constructed from non-combustible material (See Figure 3). The total amount of LPG which may be stored with the specific separation distances is shown in Table 9.

**5.8.2.2** The required minimum separation distance from any building, boundary or fixed ignition source is determined by consideration of the total amount of LPG stored, or the size of the maximum stack in the storage area. Of the two considerations, that resulting in the greater distance is the one to be applied. The distances refer to the horizontal distance in plan between the nearest cylinder and the reference feature.

**5.8.2.3** For the purpose of determining the minimum separation distance required from any building, boundary or fixed ignition source in relation to the total amount of LPG stored, individual storage areas within a single enclosed area may be considered separately provided

that the distance from any cylinder in one storage area to any cylinder in an adjacent storage area is not less than the sum of the minimum separation distance appropriate to each area in accordance with Table 9. The distance in column 2 are the distances across open ground, but the provision of radiation walls permit this distances to be reduced as shown in column 3.

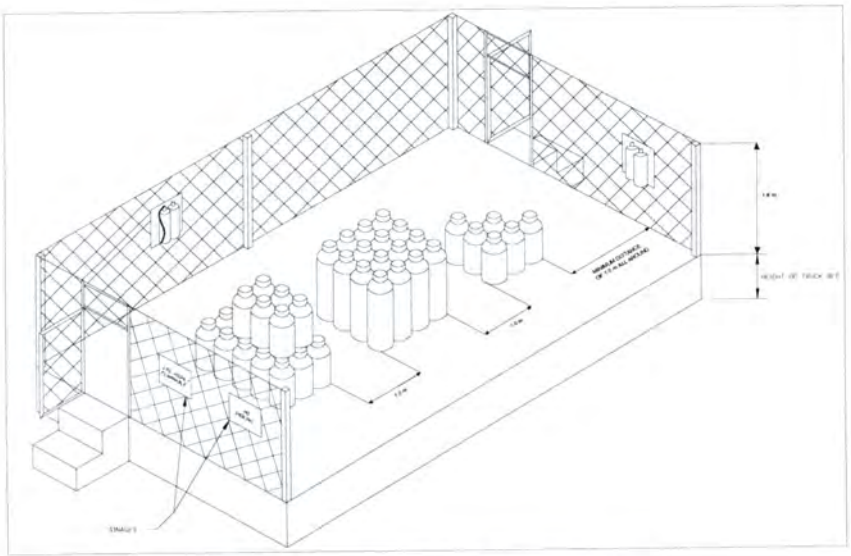

**Figure 3 – Open-air cylinder storage**

**Table 9 – Minimum separation distance for open air storage**

| Total LPG<br><br>Kg | Minimum separation distance storage to boundary or fixed ignition source from the nearest cylinder (where no fire wall is provided)<br>M | Minimum separation distance to boundary or fixed ignition source from radiation wall (where provided)<br>m | Size of stack<br><br>Kg |
|---|---|---|---|
| Up to 400 | 1 | Nil | 400 |
| 400 – 1,000 | 3 | -1.0 | 1,000 |
| 1,000 – 4,000 | 4 | 1.0 | 1,000 |
| 4,000 – 6,000 | 5 | 1.5 | 3,000 |
| 6,000 – 12,000 | 6 | 2.0 | 3,000 |
| 12,000 – 20,000 | 7 | 2.5 | 7,000 |
| 20,000 – 30,000 | 8 | 3.0 | 9,000 |
| 30,000 – 50,000 | 9 | 3.5 | 9,000 |
| 50,000 – 60,000 | 10 | 4.0 | 10,000 |
| 60,000 – 100,000 | 11 | 4.5 | 10,000 |
| 100,000 – 150,000 | 12 | 5.0 | 20,000 |
| 150,000 – 250,000 | 15 | 6.0 | 30,000 |
| Above 250,000 | 20 | 7.0 | 30,000 |

**5.8.2.4** The LPG storage place should be enclosed by an industrial type fence of not less than 1.8 m high unless it is otherwise adequately protected (e.g. within a greater fenced area). The fence should have at least two means of exit not adjacent to one another. Gates should open outwards, should not be self-locking and should at all times provide easy means of escape from within. They should be located in such a way that they do not impede any other escape route.

**5.8.2.5** All LPG cylinders storage places shall be clearly marked with notices on each externally visible side and presence at entrances to the storage area indicating the presence of LPG. These notices shall indicate:

a) A warning notice – 'Highly Flammable LPG',
b) The warning symbol – Flammable Gas, and
c) The prohibition sign – No smoking or naked flames.
d) Emergency contact numbers in case of gas leak or fire: BFP, nearest hospital, LGU (Disaster Risk Reduction and Management Office.

**5.8.2.6** LPG cylinders totaling 50 kg or more should be separated from other hazardous materials as shown below:

| | |
|---|---|
| a) Compressed gas cylinders | 3 meters |
| b) Acetylene cylinders | 3 meters |
| c) Tanks containing flammable liquids | 3 meters |
| d) Bunds of tanks containing highly flammable liquids | 3 meters |
| e) Materials and substances whose major risk is toxicity, corrosivity, explosion or combustibility | 3 meters |
| f) Liquid oxygen installations | 7.5 meters |
| g) LPG filling plant buildings | 7.5 meters |
| h) LPG bulk storage over 5000 liters and less | 3 meters |

These distances may be reduced by the use of a radiation barrier.

**5.8.2.7** The position chosen for storage shall be at ground level and never below in cellars or basement and be readily accessible.

**5.8.2.8** Drains should be avoided in the floor of the storage place or in the immediate vicinity, i.e. within 3 m of the storage place (or 2 m in the case of storage below 400 kg.). Where a gully or drain is unavoidable within this distance, the opening must either be securely covered or the drain fitted with a suitable water seal.

**5.8.2.9** Any loading platform, and any roof provided over a storage place, shall be predominantly constructed from a non-combustible material.

**5.8.2.10** The floor of the storage area should be level, free from depressions and compacted or paved with a suitable material.

**5.8.2.11** Suitable hard standing should be provided for the reception and dispatch of cylinders.

**5.8.2.12** Stacks and gangways should conform to the following:

a) The maximum size of any stack should not exceed 30,000 kg.
b) The gangway between palletized stacks should not be less than 2.5 m.
c) The gangway between unpalletized stacks should not be less than 1.0 m.

d) The maximum height of any unpalletized stacks should not exceed 2.5 m. For filled 11kg cylinders, the maximum stacking height shall be limited 2 cylinders high. For empty 11kg cylinders, up to 3 cylinders high is allowed.

e) The maximum number of pallets in any vertical column of a palletized stack should not exceed seven. The amount of LPG in any column of a stack should not exceed as shown in Table 10.

**Table 10 – Amount of LPG in column of stacks**

| Amount of LPG in any cylinder | Amount of LPG in any column | |
|---|---|---|
| Kg | Palletized, kg | Non-palletized, kg |
| Up to 6 | 35 | 30 |
| 6-15 | 75 | 45 |
| 15-20 | 80 | 50 |
| 20-55 | 110 | 55 |

## 5.9 Storage of nominally empty cylinders

**5.9.1** The storage areas for empty cylinders (gas-freed) should be clearly identified and separated from the storage area for filled cylinders. All such storage shall be in the open air and subject to strict supervision.

**5.9.2** Provided that the requirements in paragraph 5.9.1 are fully met, empty cylinders may be stored within the appropriate safety distances given in 5.8.2 and Table 10. Provided that, in addition, no such empty cylinder is stored nearer than 1.5 m from any filled cylinder, and that a minimum distance of 1 m is maintained between any empty cylinder from a boundary, building, or fixed ignition source.

## 5.10 Storage within buildings

**5.10.1** Buildings used for storage of LPG should be constructed of predominantly non-combustible material. It can have a maximum of 5 rooms or compartments, each of which is designed especially for this purpose. It should be single story and not below ground level, with no floor openings or drains.

**5.10.2** The maximum quantity of LPG in cylinders or cartridges that may be stored within a building is 5,000 kg. If the building is used to store only cartridges, up to 50,000 kg of LPG may be stored in each separate compartments.

**5.10.3** Access to storage places within buildings must be strictly controlled to prevent trespassing and unauthorized tampering. Access of vehicles and mechanical handling equipment into the storage area must also be strictly controlled.

**5.10.4** The external distance from any opening in the walls of a building which is used for the storage of LPG to the nearest opening in any other building, or to the boundary (except where this is an imperforate wall at least as high as the opening and having at least one hour fire resistance), or to any source of ignition or smoking permitted areas, or to motor vehicles (except those actually delivering/ collecting LPG cylinders) shall be one (1) meter where the quantity stored is not more than 400 kg or the separation distance given in Table 9 in all other cases.

**5.10.5** The general principles for ventilation and explosion relief are that not less than 10 % of the area of the walls and roof of a building in which LPG is stored should be used for the purpose, divided into 2.5 % fixed ventilation and 7.5 % explosion relief.

**5.10.6** If there is a risk of persons being trapped inside the building during a fire, a second exit must be provided, not adjacent to the first, one of which should preferably lead to the open air. Doors must open outwards, and at all times provide easy means of escape from within, at the same time ensuring that, in opening, they do not impede any other escape route.
**5.10.7** Where practicable, no electrical apparatus should be installed within the storage place or outside within the horizontal separation distances given in Table 9.

### 5.11 Storage of LPG in specially designed separate buildings

**5.11.1** LPG cylinders may be stored in specially designed separate buildings subject to compliance with 5.8.1 and 5.10 and the requirements below.

**5.11.2** The buildings shall be at ground level and of single story construction. It shall be made of non-combustible material and including the doors and roof, have a fire resistance, of not less than one hour.

**5.11.3** The quantity of LPG stored in specially designed building or compartment of a building shall not exceed 5000 kg. No building shall have more than five compartments. Individual compartments must be separated from each other by an imperforate wall of not less than one-hour fire resistance.

**5.11.4** The building shall be separated from other buildings or boundary by the separation distance in Table 10 or by an imperforate wall of not less than one-hour fire resistance. One wall of the building may be built on the boundary provided that it does not include any openings. If the capacity of the storage area is less than 400 kg and no cylinder is of greater capacity than 22 kg, the standard of this paragraph may be reduced, but the separation from other buildings shall be not less than 1 m.

**5.11.5** No drains or opening shall be allowed in the floor of the building.

**5.11.6** The building shall have well dispersed ventilation openings at both high levels equivalent to at least 2.5 % of the area of the walls and roof. The ventilation openings into other buildings. The ventilated walls must discharge directly on to a public pavement. The building shall have an area equivalent to at least one wall or the roof and the roof made of open mesh, or lightweight material that could act as relief in the event of an explosion.

### 5.12 Fire walls

**5.12.1** Fire walls may be considered to reduce the required separation distances where the normal separation distance cannot be achieved.

**5.12.2** Fire walls must be imperforate, and substantially constructed from brick, concrete, or such other materials so that they have a standard fire resistance of not less than 1 hour, in accordance with BS 476 Part 8. They shall be at least as high as the height of the highest stack of cylinders stored, but should be not more than 2.5 m high. They shall be of such a length that the distance from any cylinder to a boundary or fixed ignition source measured around the end of the wall is not less than the separation distance specified in 5.8.2 and Table 9.

**5.12.3** The fire wall may be a wall of a building, in which case the following additional requirements must be met:

a) There must be no openings in the wall above the cylinders stored or within 2 m horizontally.
b) There must be no overhanging eaves or similar projections constructed from combustible materials above any stored cylinder. No external stairway or fire escape shall be positioned above cylinders or allowed to terminate in the storage area.

Cylinders may be stacked against a firewall provided the quantity involved is 400 kg or less. For quantities of more than 400 kg, a 1 m space should be maintained between the stacked cylinders and firewall to allow inspection and access to leaking cylinder.

## 6 Piping, valves and equipment

### 6.1 General

**6.1.1** Piping, valves, and equipment shall be suitable for LPG service at the minimum design temperature and the maximum pressure.

**6.1.1.1** The design and fabrication of piping systems shall be in accordance with ASME B31.3, *Process Piping*, except as modified by the provisions of this chapter and any applicable national pipeline regulations.

**6.1.1.2** Where fire exposure to equipment is anticipated, the material shall be selected for fire exposure or protected from fire exposure.

**6.1.1.3** Pressure-containing metal parts of equipment for application temperatures of –29 °C (–20 °F) or above shall be fabricated of one of the following materials:

a) Steel;
b) Ductile (nodular) iron in accordance with ASTM A 395, Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures, or malleable iron in accordance with ASTM A 536, Specifications for Ductile Iron Castings, Grade 60-40-18 or 65-45-12; and
c) Malleable iron in accordance with ASTM A 47, Standard Specification for Ferritic Malleable Iron Castings; brass; bronze; or equivalent copper alloys.

**6.1.1.4** Piping that can contain liquid LPG, that can be isolated by valving, and that requires hydrostatic relief valves, shall have as a minimum a design pressure of 2.41 MPa (350 psi) or the maximum discharge pressure of any pump or other source feeding that piping system, whichever is greater.

**6.1.1.5** The piping specified in 6.1.1.4 shall be subjected to a pressure test, in accordance with 6.1.1.1, of no less than 130 percent of the design pressure same as the test requirement for the storage tank under ASME Section VIII Division 1.

**6.1.2** Piping connections to the tanks for sizes over two (2) inch nominal pipe diameter excluding excess-flow valves shall be made by welding or with welded flanges.

**6.1.3** Cast-iron valves, pipe, and fittings shall be not be used in piping that carries LPG and LPG–air mixtures, except for tank valves or fittings made of malleable or ductile iron used within the limitations set forth in ASME B31.3, Process Piping.

**6.1.4** Type-approved emergency shutoff valves shall incorporate all of the following means of closing:

a) Automatic shutoff through thermal (fire) actuation;
b) Manual shutoff from two or more remote locations; and
c) Manual shutoff at the installed location.

**6.1.5** Fusible elements used for closing emergency shutoff valves shall have a melting point not exceeding 121 °C (250 °F).

**6.1.6** Gaskets used to retain LPG in flanged connections in piping containing liquid LPG and LPG vapor above 125 psi shall meet the following requirements:

a) They shall be resistant to the action of LPG;
b) They shall be of metal or other suitable material that is confined in metal that has a melting point over 816 °C (1500 °F) or shall be protected against fire exposure;
c) When a flange is opened, the gasket shall be replaced;

**6.1.7** All piping, tubing, fittings, and valves shall be leak tested after assembly and proved to be free of leaks at not less than normal operating pressures. Tests shall not be made with a flame.

**6.1.8** Provision shall be made for expansion, contraction, jarring, vibration, and settling.

**6.1.9** Piping outside buildings shall be supported and protected against physical damage and corrosion.

**6.1.10** Underground and submerged piping shall be protected and maintained to minimize corrosion.

**6.1.11** Piping system shall conform to the provisions of a recognized piping standard i.e. ASME B31.3:2005, Process Piping or an equivalent international accepted Standard for Pressure Piping.

### 6.2 Filler and discharge pipes and manifolds.

**6.2.1** Piping connections between tank and manifold shall be designed to provide allowances for contraction, expansion, vibration, and settlement. Compression-type couplings shall not be permitted for this purpose.

**6.2.2** Liquid manifold connections shall be located at nonadjacent ends of parallel rows of tanks.

**6.2.3** The use of nonmetallic hose shall be prohibited for interconnecting stationary tanks.

**6.2.4** In the design of the liquid piping system, shutoff or block valves shall be installed to limit the volume of liquid that could be discharged in the vicinity of tanks or important structures in the event of a liquid line failure.

a) Automatically or remotely controlled valves, or both, of the fail-safe type shall be used.
b) The mechanism for such valves shall be provided with a secondary control equipped with a fusible release [not over 121 °C (250 °F) melting point] that will cause the valve to close automatically in case of fire.
c) Fail-safe valves also shall be capable of being operated manually at the installed location.
d) A remote closing control shall be located so as to be accessible during a fire or other emergency.
e) Where installed in aboveground piping systems, fail-safe valves shall be arranged to limit the quantity that could be discharged within 91.4 m (300 ft) of a tank, important building, or line of adjoining property that can be built upon to a maximum of 1.89 $m^3$ (500 gal) of liquid.

### 6.3 Pipes, tubings and fittings

Metallic pipes and pipe fittings to an acceptable thickness suitable to withstand 2.5 times the maximum operating pressure may be used for LPG piping. Pipes shall preferably be wrought iron or steel, seamless and can be either low carbon steel or hot dipped galvanized low carbon steel. They may be threaded, flanged or welded provided they comply with the following requirements:

a) Piping subjected to pressure 125 psi and above:
Threaded – low carbon steel or hot dipped galvanized low carbon steel seamless pipe Schedule 80
Welded – low carbon steel or hot dipped galvanized low carbon steel seamless pipe Schedule 40 or heavier

b) Piping subjected to less than 125 psi:
Threaded – low carbon steel or hot dipped galvanized low carbon steel seamless or welded seam pipe Schedule 40 or heavier
Welded – low carbon steel or hot dipped galvanized low carbon steel seamless or welded seam pipe Schedule 40

**6.3.1** Pipe fittings and flanges used shall be suitable for the pipe thickness used. Threaded fittings should only be used for joint sizes of 50 mm or less although threaded joint up to and including 80mm are accepted for proprietary items such as valves, pumps, meters, etc. Joints above these sizes should be made by welding or by welded flanges.

**6.3.2** Pipe joints 50 mm or over in nominal size shall be welded or flanged. Pipes and fittings used shall be Sch. 40 or heavier. Joints less than 50 mm in nominal size may be welded, flanged or screwed with taper threads conforming to API standards. Pipes and fittings used should be Sch. 80 or heavier.

**6.3.3** Pipelines in which liquid LPG may be trapped, e.g. between shut-off valves, shall be protected against excessive pressure caused by thermal expansion of the contents e.g. hydrostatic relief valve. If pressure-relieving devices discharge to atmosphere, the discharge should not endanger personnel or equipment.

**6.3.4** Pipelines shall be adequately supported and have adequate flexibility to compensate for thermal expansion, contraction, or any operational stresses. Distances between pipe supports shall comply with Table 11.

**Table 11 – Distance between pipe supports**

| Pipe size (15 mm) | Span (m) |
|---|---|
| 15 | 2.0 |
| 20 | 2.5 |
| 25 | 3.0 |
| 40 | 3.5 |
| 50 | 4.0 |

**6.3.5** Buried steel pipe work shall be adequately protected against corrosion.

**6.3.6** Valves and fittings shall be made of steel, hot stamping brass or nodular iron with equivalent strength and ductility over the design pressure and temperature range. Cast iron valves and fittings other than those of nodular iron shall not be used.

**6.3.7** Hoses shall be suitable for the grade of LPG which they are to handle. They shall be designed to withstand a minimum bursting pressure of four times the maximum pressure they will carry in normal service.

**6.3.8** Shut-off valves shall be incorporated at the ends of all pipelines to which properly identified hoses are connected.

**6.3.9** All piping shall be color coded and properly identified and labelled. The company must have this coding incorporated in their safety and operation manuals. See example from ASME A13.1 below. For liquid LPG, the piping color should be blue while for vapor LPG the color should be yellow.

**Table 12. Designation of Colors (ASME A13.1)**

| Fluid Service | Background Color | Letter Color | Color and Letter Sample |
|---|---|---|---|
| Fire quenching fluids | Safety red | White | Letters |
| Toxic and corrosive fluids | Safety orange | Black | Letters |
| Flammable fluids | Safety yellow | Black | Letters |
| Combustible fluids | Safety brown | White | Letters |
| Potable, cooling, boiler feed, and other water | Safety green | White | Letters |
| Compressed Air | Safety blue | White | Letters |
| To be defined by the user | Safety purple | White | Letters |
| To be defined by the user | Safety white | Black | Letters |
| To be defined by the user | Safety gray | White | Letters |
| To be defined by the user | Safety black | White | Letters |

**6.3.10** Flanges used must be machined and should preferably be provided with a raised face. Gaskets used in flanged connections shall be resistant to action of LPG and preferably be 1.6 mm (1/16 in.) thickness.

**6.3.11** Gaskets for flanged joints shall be resistant to liquid phase LPG. Gaskets shall be spiral wound, AISI 316, graphite-filled or PTFE filled gaskets. Gasket of natural rubber or

bonded with natural rubber shall not be used. Compressed Asbestos Fiber (CAF) gaskets are not acceptable.

## 7 Electrical system

### 7.1 Electrical requirement

The selection, installation and use of electrical apparatus including wiring and cabling in hazardous areas shall be in accordance to the required standard for the zone classification.

Area classification:

The areas detailed in Table 12 below are classified according to the degree of probability that flammable concentrations of gas (vapor) may arise. The hazardous area definitions are as follows.

Zone 0 An area in which an explosive gas-air mixture is continuously present, or present for long periods.

Zone 1 An area in which an explosive gas-air mixture is likely to occur in normal operation.

Zone 2 An area in which an explosive gas-air mixture is not likely to occur in normal operation, and if it occurs it will only exist for a short time.

NOTE Storage within buildings and the areas within separation distances shall be designed as Zone 2 as indicated in Table 12.

**Table 13 – Area electrical classification**

| Location | Extent of classified area | Area classification |
|---|---|---|
| Cylinder storage space of the type described in 5.8.2 | In the storage space up to a height of 1.5 m above the top of the stack, or beneath any roof over the storage space.<br>Outside the storage space or the space covered by any roof up to 1.5 m above ground level and within the distance set out for a fixed source of ignition and as Figure 1. | Zone 2<br>Zone 2 |
| Cylinder storage within a building as described in 5.10 | Within the building<br>Outside any doorway, low level ventilators or any opening into store, up to 1.5 m above ground level and within the distance set out for a fixed source of ignition and as Figure 1. | Zone 2<br>Zone 2 |
| Cylinder storage within specifically designed storage places within the buildings of the type described in 5.11 | Entire storage space | Zone 2 |

NOTE 1 The distance from the nearest cylinder to a building or boundary etc. when measured around a fire wall should not be less than the distance given in column 3.

NOTE 2 The minimum distance between a firewall and the nearest cylinder should be 1 m, except for quantities up to 400 kg.

NOTE 3 A separation distance is not needed for quantities up to 400 kg if buildings and walls are suitably constructed.

**7.1.1** Grounding and bonding shall be required on LPG systems.

## 7.2 Electrical equipment

**7.2.1** Electrical equipment and wiring installed in unclassified areas shall be in accordance with NFPA 70, National Electrical Code, for non-classified locations.

**7.2.2** Fixed electrical equipment and wiring installed within a classified area specified in Table 13 shall be installed in accordance with NFPA 70, National Electrical Code and the Philippine Electrical Code.

**Table 14 – Electrical area classification**

| Part | Location | Extent of Classified Area | Equipment Shall be Approved for *National Electrical Code,* Class $I_a$, Group $D_b$ |
|---|---|---|---|
| A | Unrefrigerated tanks other than cylinders and vertical tanks of less than 454 kg (1000 lb) water capacity | Within 4.6m (15 ft) in all directions from connections, except connections otherwise covered in Table 13 | Division 2 |
| B | Tank vehicle loading and unloading | Within 1.5m (5 ft) in all directions from connections regularly made or disconnected for product transfer | Division 1 |
| | | Beyond 1.5m (5 ft) but within 4.6m (15ft) in all directions from a point where connections are regularly made or disconnected and within the cylindrical volume between the horizontal equator of the sphere and grade *(see Figure 4)* | Division 2 |
| C | Gauge vent openings other than those on cylinders and vertical tanks of less than 454 kg (1000 lb) water capacity | Within 1.5 m (5 ft) in all directions from point of discharge | Division 1 |
| | | Beyond 1.5 m (5 ft) but within 4.6 m (15 ft) in all directions from point of discharge | Division 2 |
| D | Relief device discharge other than those on cylinders and vertical tanks of less than 454 kg (1000 lb) water capacity and vaporizers | Within direct path of discharge | NOTE Fixed Electrical Equipment should preferably not be installed. |
| E | Pumps, vapor compressors, gas–air mixers and vaporizers (other than direct-fired or indirect-fired with an attached or adjacent gas-fired heat source) | | |
| | Indoors without ventilation | Entire room and any adjacent room not separated by a gastight partition | Division 1 |

| | | | |
|---|---|---|---|
| | | Within 4.6 m (15 ft) of the exterior side of any exterior wall or roof that is not vaportight or within 4.6 m (15 ft) of any exterior opening | Division 2 |
| | Indoors with ventilation | Entire room and any adjacent room not separated by a gastight partition | Division 2 |
| | Outdoors in open air at or above grade | Within 4.6 m (15 ft) in all directions from this equipment and within the cylindrical volume between the horizontal equator of the sphere and grade *(see Figure 4)* | Division 2 |
| F | Pits or trenches containing or located beneath LPG valves, pumps, vapor compressors, regulators, and similar equipment | | |
| | Without mechanical ventilation | Entire pit or trench | Division 1 |
| | | Entire room and any adjacent room not separated by a gastight partition | Division 2 |
| | | Within 4.6m (15ft) in all directions from pit or trench when located outdoors | Division 2 |
| | With mechanical ventilation | Entire pit or trench | Division 2 |
| | | Entire room and any adjacent room not separated by a gastight partition | Division 2 |
| | | Within 4.6m (15ft) in all directions from pit or trench when located outdoors | Division 2 |
| G | Special buildings or rooms for storage of Cylinders | Entire room | Division 2 |
| H | Pipelines and connections containing operational bleeds, drips, vents, or drains | Within 1.5 m (5 ft) in all directions from point of discharge | Division 1 |
| | | Beyond 5 ft (1.5 m) from point of discharge, same as part F of this table | |
| I | Cylinder filling | | |
| | Indoors with ventilation | Within 1.5 m (5 ft) in all directions from a point of transfer | Division 1 |
| | | Beyond 1.5m (5 ft) and entire room | Division 2 |
| | Outdoors in open air | Within 1.5 m (5 ft) in all directions from a point of transfer | Division 1 |
| | | Beyond 1.5 m (5 ft) but within 4.6 m (15 ft) in all directions from point of transfer and within the cylindrical volume between the horizontal equator of the sphere and grade *(see Figure 4)* | Division 2 |
| J | Piers and wharves | Within 1.5 m (5 ft) in all directions from connections regularly made or disconnected for product transfer | Division 1 |
| | | Beyond 1.5 m (5 ft) but within 4.6 m (15 ft) in all directions from a point where connections are regularly made or disconnected and within the cylindrical volume between the horizontal equator of the sphere and the vessel deck *(see Figure 4)* | Division 2 |

The classified area shall not extend beyond an un-pierced wall, roof, or solid vaportight partition.

See Article 500 Hazardous (Classified) Locations, in NFPA 70, *National Electrical Code*, for definitions of classes, groups, and divisions.

**7.2.3** The provisions of 7.2.2 shall apply to vehicle fuel operations.

**7.2.4** The provisions of 7.2.2 shall not apply to fixed electrical equipment at residential or commercial installations of LPG systems or to LPG systems on vehicles.

**7.2.5** Fired vaporizers, calorimeters with open flames, and other areas where open flames are present either intermittently or constantly shall not be considered electrically classified areas.

**7.2.6** Electrical equipment installed on LPG cargo tank vehicles shall comply with Section 9.2 of NFPA 58.

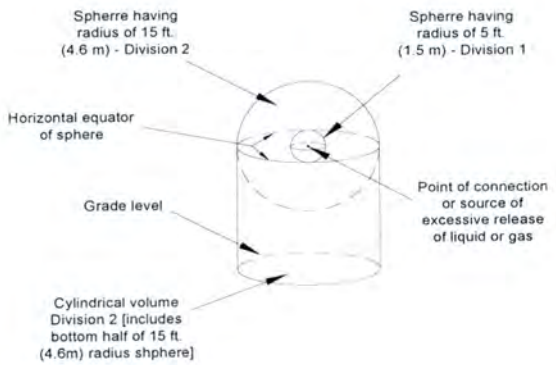


**Figure 4 – Extent of electrically classified area**

## 7.3 Source of Ignition

**7.3.1** Smoking and non-process ignition sources within the protective enclosure shall be prohibited, unless in accordance with 7.3.2 through 7.3.4.

**7.3.2** Smoking shall be permitted only in designated and properly signposted areas.

**7.3.3** Welding, cutting, hotworks, use of portable electric tools and extension lights, and similar operations shall be conducted only at times and places specifically authorized.

**7.3.3.1** Welding and cutting shall be conducted in accordance with the provisions of NFPA51B, Standard for Fire Prevention During Welding, Cutting, and Other Hot Work. Portable electric tools and extension lights capable of igniting LPG shall not be permitted within the classified areas specified in Table 13.

**7.3.3.2** Portable electric tools and extension lights capable of igniting LPG shall be permitted where the LPG facilities have been freed of all liquid and vapor or where special precautions are observed under carefully controlled conditions.

**7.3.4** Vehicles and other mobile equipment that constitute potential ignition sources shall be prohibited within diked areas or within 15 m (50 ft) of containers that contain LPG, flamable liquids, or flammable refrigerants, except where specifically authorized and under constant supervision or where loading or unloading at facilities specifically designed for the purpose.

**7.3.5** Electrical grounding and bonding shall be provided as required by NFPA 70, National Electrical Code.

**7.3.6** If stray currents are present or if impressed currents are used on loading and unloading systems (such as for cathodic protection), protective measures shall be taken to prevent ignition.

**7.3.7** Metallic storage containers for LPG generally do not require lightning protection. Grounding systems shall be provided for LPG storage containers in accordance with Chapter 3, Section 4.4, and 6.3.2 of NFPA 780, Standard for the Installation of Lightning Protection Systems.

### 7.4 Other sources of ignition

**7.4.1** Open flames or other sources of ignition shall not be used or installed in pump houses, cylinder filling rooms, or other similar locations.

**7.4.2** Open flames, cutting or welding tools, portable electric tools, and extension lights capable of igniting LPG shall not be installed or used within classified areas specified in Table 13.

**7.4.3** Open flames or other sources of ignition shall not be prohibited where LPG facilities have been purged of all liquid and vapor.

### 7.5 Lighting

Lighting shall be provided to illuminate operating facilities such as walkways, essential control valves, and loading and unloading facilities in particular and shall comply with 7.2.1 and Table 13.

## 8 Buildings and structures housing LPG distribution facilities

This clause applies to the construction, ventilation, and heating of structures, parts of structures, and rooms housing LP-Gas systems where specified by other parts of the code.

### 8.1 Construction of structures or buildings

**8.1.1** Separate buildings or structures shall be one story in height and shall have walls, floors, ceilings, and roofs constructed of noncombustible materials.

**8.1.2** Either of the following shall apply to the construction of exterior walls, ceilings, and roofs:

a) Exterior walls and ceilings shall be of lightweight material designed for explosion venting; and
b) Walls or roofs of heavy construction, such as solid brick masonry, concrete block, or reinforced concrete construction, shall be provided with explosion venting windows that have an explosion venting area of at least 0.1 $m^2$ (1 $ft^2$) for each 1.4 $m^3$ (50 $ft^3$) of the enclosed volume.

**8.1.3** The floor of separate structures shall not be below ground level.

## 9 Pressure relief devices

### 9.1 General

**9.1.1** Relief devices of tanks shall be arranged so that the possibility of tampering is minimized.

**9.1.2** If the pressure setting or adjustment is external, the relief devices shall be provided with an approved means for sealing the adjustment.

**9.1.3** Each tank relief device shall be marked with the pressure in pounds per square inch at which the device is set to start to discharge, with the actual rate of discharge in cubic feet per minute of air at 16 °C (60 °F) and an absolute pressure of 0.101 MPa (14.7) psia.

### 9.1.4 Testing relief devices

**9.1.4.1** Pressure relief valves should be replaced every 5 years (or as recommended by the valve manufacturer) with new units set at a pressure not exceeding the tank maximum working pressure. Pressure relief valves more than 12 years old shall not be re-used. The test date and other details stamped on the body should be checked. At the same time consideration should be given to replacing any non-corrosion protected stack pipes with galvanized or equivalent. To facilitate removal, stack pipes should not be fitted into valves using sealing compounds. PTFE tape is sufficient.

Relief valve drain holes should be checked to ensure they are clear. Where internal corrosion of stack pipes is suspected i.e. if rain caps are missing and/or corrosion resistant pipes are not used, consideration should be given to the removal of the stack pipes for examination of the relief valve to ensure that their operation would not be jeopardized by corrosion or corrosion debris. Missing rain caps shall be replaced.

Relief devices shall be installed directly to storage tank and provided with LPG compatible thread sealant. An intervening valve may be installed between the tank and the PRV provided that the following conditions are strictly observed:

1. Procedures must be in place to ensure that the intervening valve shall always be on the open position.
2. Remove the actuating lever or have the same in a locked open position.
3. A tag shall be placed informing that the intervening valve shall always be in an open position.
4. In no case shall be that the intervening valve be closed in the event that the PRV is relieving pressure of the tank.
5. In no case shall be that the intervening valve be used as replacement to a malfunctioning or defective PRV. Immediately replace a malfunctioning or defective PRV.

**9.1.4.2** A pressure relief valve shall not be removed from a multiport or check device while a tank is under pressure unless a serviceable replacement is available to be immediately fitted.

**9.1.4.3** No attempt to remove a pressure relief valve mounted in a tank under pressure must be made unless the pipe and construction of the check device can be identified and the manufacturer's instructions for the safe removal of the relief valve are fully understood.

These devices shall include positive means of confirming that the check device has closed before unscrewing the relief valve proceeds to an otherwise dangerous stage.

### 9.2 Relief devices for non-refrigerated tanks

**9.2.1** Tanks shall be equipped with one or more pressure relief valves that are designed to relieve vapor.

**9.2.2** Tanks shall be equipped with one or more pressure relief valves designed both to "start to discharge" and to attain full flow at pressures in accordance with design code of the tank to which they are fitted. The rate of discharge from the relief valves when fully open shall be at least that which is required by Annex E – (Pressure relief devices) of NFPA 58 for tanks exposed to open fire conditions

**9.2.3** Tanks for LPG shall be equipped with direct spring-loaded pressure relief valves conforming with applicable requirements of UL132, Standard on Safety Relief Valves for Anhydrous Ammonia and LP-Gas, or other equivalent pressure relief valve standards.

**9.2.3.1** The start-to-leak setting of such pressure relief valves, in relation to the pressure rating of the tank, shall be in accordance with Table 14.

**9.2.3.2** Tanks of 40,000 gal (151 $m^3$) or more water capacity shall be equipped with either a spring-loaded pressure relief valve or a pilot-operated pressure relief valve, as follows:

a) The pilot-operated relief valve shall be combined with and controlled by a self-actuated, direct, spring-loaded pilot valve that complies with Table 14.
b) The use of a pilot-operated pressure relief valve shall be approved.
c) Pilot-operated pressure relief valves shall be inspected and maintained by persons with training and experience, and shall be tested for operation at intervals not exceeding 5 years.

**Table 15 – Start-to-leak pressure settings of pressure relief valves in relation to tank pressure rating**

| Tanks | Minimum | Maximum |
|---|---|---|
| All ASME codes prior to the 1949 edition, and the 1949 edition, paragraphs U-68 and U-69 | 110 % | 125 %* |
| ASME code, 1949 edition, paragraphs U-200 and U-201, and all ASME codes later than 1949 | 100 % | 100 %* |
| * Manufacturers of pressure relief valves are allowed a plus tolerance not exceeding 10 percent of the set pressure marked on the valve. | | |

**9.2.4** The minimum rate of discharge of pressure relief valves shall be in accordance with Table 15 or shall be calculated using the following formula:

$$\text{Flow rate (ft}^3\text{ /min air)} = \square 53.632 \times A^{0.82}$$

Where,

$A$ is the total outside surface area of container in square feet.

**9.2.5** Relief valves for aboveground tanks shall relieve at not less than the flow rate specified in 9.2.4 before the pressure exceeds 120 % of the minimum permitted start-to-leak pressure setting of the device. This does not include the 10 % tolerance in Table 14.

**9.2.6** The flow capacity of pressure relief valves installed on underground or mounded tanks shall be permitted to be reduced to 30 % of the flow specified in Table 15.

**9.2.7** Each pressure relief valve shall be plainly and permanently marked with the following:

a) The pressure in psig at which the valve is set to start-to-leak.
b) Rated relieving capacity in cubic feet per minute of air at 16 °C (60 °F) and 101 kPa (14.7 psia).
c) The manufacturer's name, catalog and serial number.
d) Date of manufacture

**Table 16 – Pressure relief valve flow capacity as a function of tank surface area**

| Surface area ($ft^2$) | Flow rate ($ft^3$ / min air) | Surface area ($ft^2$) | Flow rate ($ft^3$ / min air) | Surface area ($ft^2$) | Flow rate ($ft^3$ / min air) |
|---|---|---|---|---|---|
| ≤ 20 | 626 | 170 | 3620 | 600 | 10,170 |
| 25 | 751 | 175 | 3700 | 650 | 10860 |
| 30 | 872 | 180 | 3790 | 700 | 11550 |
| 35 | 990 | 185 | 3880 | 750 | 12220 |
| 40 | 1100 | 190 | 3960 | 800 | 12880 |
| 45 | 1220 | 195 | 4050 | 850 | 13540 |
| 50 | 1330 | 200 | 4130 | 900 | 14190 |
| 55 | 1430 | 210 | 4300 | 950 | 14830 |
| 60 | 1540 | 220 | 4470 | 1000 | 15470 |
| 65 | 1640 | 230 | 4630 | 1050 | 16100 |
| 70 | 1750 | 240 | 4800 | 1100 | 16720 |
| 75 | 1850 | 250 | 4960 | 1150 | 17350 |
| 80 | 1950 | 260 | 5130 | 1200 | 17960 |
| 85 | 2050 | 270 | 5290 | 1250 | 18570 |
| 90 | 2150 | 280 | 5450 | 1300 | 19180 |
| 95 | 2240 | 290 | 5910 | 1350 | 19780 |
| 100 | 2340 | 300 | 5760 | 1400 | 20380 |
| 105 | 2440 | 310 | 5920 | 1450 | 20980 |
| 110 | 2530 | 320 | 6080 | 1500 | 21570 |
| 115 | 2630 | 330 | 6230 | 1550 | 22160 |
| 120 | 2720 | 340 | 6390 | 1600 | 22740 |
| 125 | 2810 | 350 | 6540 | 1650 | 23200 |
| 130 | 2900 | 360 | 6690 | 1700 | 23900 |
| 135 | 2990 | 370 | 6840 | 1750 | 24470 |
| 140 | 3080 | 380 | 7000 | 1800 | 25050 |
| 145 | 2170 | 390 | 7150 | 1850 | 25620 |
| 150 | 3260 | 400 | 7300 | 1900 | 26180 |
| 155 | 3350 | 450 | 8040 | 1950 | 26750 |

| | | | | | |
|---|---|---|---|---|---|
| 160 | 3440 | 500 | 8760 | 2000 | 27310 |
| 165 | 3530 | 550 | 9470 | - | - |

**9.2.8** Pressure relief valves shall be designed to minimize the possibility of tampering.

**9.2.9** Externally set or adjusted valves shall be provided with an approved means of sealing the adjustment.

**9.2.10** Where used on aboveground containers of 4.5 $m^3$ (1200 gal) or less in addition to spring-loaded pressure relief valves, fusible plugs shall be in accordance with the following:

a) Have a yield point between 98 °C and 104 °C (208 °F and 220 °F);
b) Have a total discharge area not exceeding 16,100 $mm^2$ (0.25 $in.^2$); and
c) Communicate directly with the vapor space of the container.

**9.2.11** Isolation valves under individual pressure relief valves shall be locked or sealed when opened and shall not be opened or closed except by an authorized person.

### 9.3 Relief device sizing

**9.3.1 Aboveground containers** – Pressure relief devices shall be sized based on the largest flow capacity determined by the largest single condition or any reasonable and probable combination of conditions, including the following:

a) Fire exposure;
b) Operational upset, such as failure of a control device;
c) Other circumstances resulting from equipment failures and operating errors;
d) Vapor displacement during filling;
e) Flash vaporization during filling, as a result of filling or as a consequence of mixing of products of different compositions;
f) Loss of refrigeration;
g) Heat input from pump re-circulation; and
h) Drop in barometric pressure.

**9.3.2** Underground and Mounded Containers. The minimum pressure relieving capacity for underground and mounded containers shall be not less than 30 percent of the relieving capacity for aboveground un-insulated containers.

### 9.4 Pressure relief valve discharge vents

**9.4.1** All discharge vents from the pressure relief valves or common discharge headers shall be as follows:

a) They shall lead to the open air.
b) They shall be protected against mechanical damage.
c) They shall exclude or remove moisture and condensate, which shall be permitted to be done by the use of loose-fitting rain caps and drains. Drains shall be installed so as to prevent possible flame impingement on the containers, piping, equipment, and structures.

**9.4.2** All discharge vents from the pressure relief valves or common discharge headers shall be installed to achieve discharge in an area that meets the following:

a) Discharge shall prevent flame impingement on containers, piping, equipment, and structures;
b) Discharge shall prevent vapor entry into enclosed spaces; and
c) Discharge shall be located above the heads of personnel on the container or adjacent containers, stairs, or platforms, or on the ground if vents are located above the possible water level, if discharging from underground containers where there is a possibility of flooding.

**9.4.3** All discharge vents from the pressure relief valves or common discharge headers shall be installed in such a manner as to prevent malfunction due to freezing or icing.

### 9.5 Aboveground containers

**9.5.1** The discharge from the relief devices shall be vented away from the container and shall be unobstructed to the open air.

**9.5.1.1** The vents shall be fitted with loose-fitting rain caps.

**9.5.1.2** A means shall be provided to protect the container, adjacent containers, and piping of equipment against impingement of flame resulting from ignition of released product.

**9.5.1.3** The vent piping shall extend upward at least 2.2 m (7 ft) above the top of the container for tanks with a capacity of 30MT and above.

### 9.6 Underground and mounded containers

**9.6.1** The discharge pipe from pressure relief devices shall extend directly and vertically upward at least 2.2 m (7 ft) above the ground.

**9.6.2** If liquid product is placed in containers while they are not buried, the pressure relief valve sizing shall be that of aboveground containers.

**9.6.3** Where there is a probability of the manhole or housing becoming flooded, the discharge from regulator vent lines shall be above the water level.

### 9.7 Hydrostatic relief valves (Thermal expansion relief valve)

A hydrostatic relief valve shall be installed between each pair of shutoff valves on LPG liquid piping so as to relieve the pressure that could develop from the trapped liquid.

**9.7.1** Hydrostatic relief valves shall have pressure settings not less than 2.76 MPa (400 psi) or more than 3.45 MPa (500 psi) unless installed in systems designed to operate above 2.41 MPa (350 psi).

**9.7.2** Hydrostatic relief valves for use in systems designed to operate above 2.41 MPa (350 psi) shall have settings not less than 110 percent or more than 125 percent of the system design pressure.

## 10 Maintenance

### 10.1 Maintenance manuals

**10.1.1** Maintenance manuals for normally attended facilities shall be kept at the facility and shall be available to maintenance personnel.

**10.1.2** Manuals for normally unattended facilities shall be permitted to be stored at a location where they will be accessible to maintenance personnel servicing the unattended location.

**10.1.3** Maintenance manuals shall include the following:

a) Drawings, procedures, and parts lists provided by the manufacturer, installer and supplier;
b) Routine and preventative maintenance procedures and schedules;
c) Routine inspections to be performed; and
d) Corrosion inspection and control procedures, where applicable.
e) Maintenance history of all equipment
f) PPE requirements and safety precautions to be observed in the conduct of maintenance.

**10.2** Maintenance activities on fire control equipment shall be scheduled so that a minimum of equipment is taken out of service at any time and is returned to service as soon as maintenance is complete.

**10.3** Each auxiliary power source shall be tested at least monthly to verify its operational capability.

**10.4** All equipment that contains flammable or hazardous materials shall be purged prior to beginning maintenance procedures in accordance with NFPA 58, LPG Code. (Refer to purging under provisions 7.3.2 on NFPA 58)

**10.5** LOTO should be strictly implemented for electrical equipment prior to servicing.

**10.6** Records that are required shall be retained for the life of the equipment while in use, and for 3 years thereafter.

## 11 Vehicular transportation of LPG (Bottled and bulk)

This clause covers the basic requirements for the design, construction, inspection, testing and operation of vehicles including their ancillary equipment used in the transportation of portable cylinders and bulk LPG cargo. It does not apply to LPG containers and related equipment incident to their use on vehicles.

### 11.1 Cylinder transport

**11.1.1** General Requirement for Cylinders up to 150 liters (65 kg) capacity

**11.1.1.1** Portable cylinders having an individual water capacity not exceeding 150 liters (65 kg) shall be transported in accordance with the requirements of this clause.

**11.1.1.2** Cylinders to be transported shall be constructed in accordance with PNS:03-1:2000 (LPG Steel Cylinders – Specification)

**11.1.1.3** Cylinders which incorporate pressure relief valves shall be transported upright so that the pressure relief valves are always in the vapor phase.

**11.1.1.4** Cylinders being transported shall be securely fastened to prevent being damaged owing to accidental movement or their falling off from the transport vehicle.

**11.1.1.5** The cargo space of the vehicle shall be isolated from the driver's compartment, the engine, and its exhaust system. Open bodied vehicles shall be considered to be in compliance with this provision.

**11.1.1.6** Cylinder transport vehicles must have substantially flat floors and equipped with suitable racks or barriers for holding the cylinders up to the highest level of the cylinder to be stacked.

**11.1.1.7** Cylinders shall not be transported on vehicles, in ship holds or in rail boxcars which contain corrosive materials or flammable products other than petroleum products.

**11.1.1.8** LPG cylinders, when transported by sea, shall be carried either as deck cargo or in hold fitted with forced ventilation.

**11.1.1.9** Newly manufactured empty cylinder when transported shall not be governed by the above sub-clauses.

**11.1.1.10** Each vehicle transporting portable cylinders shall be equipped with at least two portable dry chemical fire extinguishers with a B:C rating having a minimum capacity of 10 lbs.

### 11.2 Cylinder transport vehicle design

**11.2.1** The engine shall be of the compression ignition type and shall be in front of the rear line of the cab or be otherwise protected so that any spillage or leakage of LPG being conveyed cannot impinge on heated surfaces of the engine.

**11.2.2** The air intake opening should be located so as to minimize the possibility of intake of flammable vapor from any discharge or leakage of LPG.

**11.2.3** The exhaust system should be located or so protected that any discharge or leakage of LPG cannot directly impinge on the heated surfaces of the system.

**11.2.4** The vehicle fuel tank should be positioned such that leaking or spilled fuel can drain directly to the ground without impinging on the engine or its exhaust system. Where this cannot be avoided, the engine or exhaust system should be so protected so the spillage cannot impinge on the heated surfaces of the system.

**11.2.5** Battery terminals should be effectively protected by a rubberized cover against inadvertent contact by objects which could cause a spark.

**11.2.6** All electric cables should be located and secured on the vehicle so that they are protected against mechanical damage, pilferage and tampering.

**11.2.7** A master switch to Zone 2 requirements must be provided as a means to isolate all electrical circuits and must be placed as near as possible to the battery and readily accessible for driver to open/close the switch from his seat.

**11.2.8** All electrical circuits, with the exception of the main battery supply, starter and alternator circuit must be protected by suitable fuses or circuit breakers in the feed side of each circuit.

**11.2.9** Cigarette lighters must not be fitted into the cab.

### 11.3 Bulk LPG transport

**11.3.1** Bulk LPG lorry must comply with the provisions of 11.2 on vehicle and engine design

**11.3.2** Tanks mounted on vehicle shall be designed, constructed, inspected and tested in accordance with DOLE Rule 1170, ASME VIII, NFPA 58 or other equivalent unfired pressure vessel codes.

**11.3.3** The design pressures of the tank shall not be less than 17.6 kg/cm$^2$ (250 psi) at the highest temperature that the contents will reach during normal service. This temperature shall not be less than 40 °C.

**11.3.4** Materials used for the tank shall be suitable for use at the lowest temperature the contents will reach in normal service, which may be below the minimum ambient temperature, and shall in any event be suitable for use at 0 °C.

**11.3.5** The design of the tank and its support shall take account of acceleration and deceleration forces of normal road transport. Tanks with internal volume of over 7.5 m$^3$ shall be fitted with baffle plates set laterally to limit longitudinal surge. They shall be designed to facilitate access through them for purposes of internal inspection of the tank.

**11.3.6** Tanks shall have adequate external protection against corrosion arising from atmospheric influences. The final painted surface of the tank should be of reflective gloss finish. Other finishes may reduce normal reflection of solar radiation.

**11.3.7** The vehicle must be provided with a rear bumper designed to provide protection for the tank and any rear mounted ancillary equipment in the event of a rear end collision. The width of the bumper should not be less than the width of the tank. The inside face of the bumper should be located at least 100 mm from the rear of the tank shell or any LPG fittings.

**11.3.8** The lower rear part of the tank should be protected by adequate steel guards or barriers.

**11.3.9** At least two (2) dry chemical BPS certified fire extinguisher of 4.5 kg (10 lbs) capacity dry chemical or $CO_2$ with B:C rating shall be provided, placed accessibly near the driver or attendant inside the driver's compartment.

### 11.4 Tank mounting

**11.4.1** Mounting structures should be fabricated in steel and be designed to comply with the requirements of the tank and chassis manufacturer. They should take into account all the additional stresses specified in the applicable codes.

**11.4.2** Mountings should be designed as an integral attachment to the shell. Each attachment should be continuously welded to the shell which shall be locally reinforced to alleviate high stress concentrations.

**11.4.3** Tanks and fittings shall be electrically bonded to the chassis of the vehicle (max. resistance 10 ohms). In the case of trailer-mounted tanks, these shall likewise be in electrical continuity with the motive unit.

### 11.5 Valves, fittings and pipings

**11.5.1** All valves, fittings and ancillary equipment shall be of suitable materials for liquid phase LPG at the maximum and minimum pressures and temperatures of service operation, for service in road vehicles. It shall be installed or fitted in accordance with manufacturer's instructions and recommendations.

**11.5.2** Joints for pipe work up to and including 50 mm nominal bore, or proprietary items such as pumps, valves and meters up to 80 mm nominal bore, may be threaded. Larger sizes of pipe should be welded or have welded flanges.

**11.5.3** Pipe material for internal pipe work shall be wrought iron or steel and pipefittings shall be steel, malleable iron or ductile iron suitable for use with the pipe material. Where the joints are threaded, or threaded and back welded, pipe and nipples shall be Sch. 80 or heavier. Where joints are welded, the pipe and nipples shall be Sch. 40 or heavier.

**11.5.4** Jointing materials, thread sealants and gaskets must be compatible with liquid LPG. Thread sealants should be non-setting.

**11.5.5** Protection against mechanical damage must be provided by the design, location or barriers, against the dangers of collision or rollover. Mechanical barriers shall not be attached to pipe work or valves which they are intended to protect.

### 11.6 Primary shut-off systems

**11.6.1** All connections to the tank with an opening out of the tank in excess of 1.4 mm diameter, other than those for pressure relief valves or those permanently fitted with blank flanges or plugs, shall incorporate a primary shut-off system. Primary shut-off systems are valves or a series of valves attached to the tank shell which serves to ensure the integrity of the tank and security of its contents. They are designed to leave a closure mechanism intact in the event of external damage.

**11.6.2** The primary shut-off system required depends upon the size and purpose of the tank connection:

a) For liquid discharge above 40 mm nominal size, a normally closed internal shut-off valve with its closure mechanism must be located within the tank and opened by hydraulic, pneumatic or mechanical means from the vehicle. It should be designed for rapid closure on actuation of its manual devices located at convenient remote positions on the vehicle and adequately labeled to indicate their use. Hydraulic and pneumatic systems should incorporate a thermally sensitive device which will ensure positive closure in the event of a fire. All closure mechanism should incorporate an excess flow valve facility.

b) For other liquid or vapor connections, except those for level gauging or pressure gauges, an excess flow valve or back-check valve, as appropriate, should be directly mounted into the tank's shut-off valve. Where access to the valve handle would be restricted, consideration should be given to shut-off valves with a remote closure facility as in (a).

c) For filling connections – only filling connections may be provided with a double back check valve in place of 11.6.2(b) provided that above 50 mm nominal bore the connection terminates in the vapor space.

d) For drain connections – primary drain connections should not exceed 50 mm nominal bore and shall comply with 11.6.1, 11.6.3 and 11.6.4.

i. Excess flow valves should be set to close at a low flow rate that likely to result from a guillotine failure of associated fittings or pipe work system for the lowest practicable system pressure. They should be set high enough to prevent chatter when pumping under normal conditions. A pressure-equalizing orifice not greater than 1.4 mm diameter shall be incorporated. The closing flow rate should not exceed 150% of the nominal flow rate.

ii. Primary valve systems should not be located at the rear of the tank if they would be vulnerable to rear collision damages, unless the risk of such damage can be shown to be negligible by adequate protection.

### 11.7 Secondary shut-off valves and systems

**11.7.1** Secondary shut-off valves and system comprises all valves and fittings not connected directly to the tank.

**11.7.2** Valves in pipe work for liquid transfer or vapor equalizing connections used for routine operations should be fire-safe, located as close as practicable to the end of the rigid pipe work, and as close as possible to the final hose inlet.

**11.7.3** Intermediate valve should be provided to enable individual isolation of the pump or meter. Consideration should be given to automatic closure of these valves by incorporation in the remote closure system of the primary internal valve.

**11.7.4** Any secondary valves and pipe work for drain connections shall comply with 11.7.

### 11.8 Other connections

All other connections to the tank except pressure relief and liquid level gauge connections relying on a bleed to atmosphere should be provided with:

a) suitable excess-flow valves with pressure equalizing orifice not greater than 1.4 mm diameter or
b) quick closing internal valves designed to remain closed except during delivery or charging, or
c) back pressure check valves.

### 11.9 Pressure relief valves

**11.9.1** Tanks shall be equipped with one or more pressure relief valves of sufficient capacity and having direct access to the vapor space of the vessel. The start-to-discharge pressure shall not be greater than the tank design pressure.

**11.9.2** Pressure relief valves shall be of the internal spring-loaded type should be designed and fitted so as to prevent water accumulating on the discharge side.

**11.9.3** Pressure relief valves shall be designed and fitted to ensure that in the case of ignition of discharged product, flame impingement on the tank is avoided.

**11.9.3.1** The valve seat of the pressure relief valve shall preferably be within the tank, otherwise they shall be protected against possible impact damage. Shroud protection should be designed so that distortion caused by impact will not prevent the relief valve from operating.

**11.9.3.2** Each pressure relief valve should be plainly and permanently marked with the following:

a) Manufacturer's name
b) Month and year of manufacture e.g. 09/05
c) Nominal set pressure
d) Valve type number
e) Discharge capacity quoted in $m^3$/min. ($ft^3$/min.) of air at standard conditions.

**11.9.4** All tank connections, e.g. inlets, liquid-level contents gauge connections, etc., excluding relief valve connections should be labeled to designate their purpose.

### 11.10 Contents gauges and level gauges

**11.10.1** All tanks shall be fitted with a suitable and contents gauge. Such gauges if used for custody transfer purposes must be calibrated by BPS accredited calibration laboratory.

**11.10.2** If the contents of the tank are to be measured by volume with a rotary dip tube or magnetic gauge, one or more fixed maximum liquid level gauges as a check on these gauges should be provided.

**11.10.3** Fixed maximum liquid level gauge should be set to 85 % of the total liquid volume of the LPG to be carried.

**11.10.4** Any gauging device that relies on bleeding to atmosphere, such as rotary dip tube or fixed tube shall be such that:

a) The bleed hole maximum opening is not larger than 1.4 mm diameter otherwise it shall be protected by a shut-off valve and a suitable excess flow valve.
b) The operational bleed screw shall remain captive at all times.
c) The gland is capable of being replaced without withdrawing the tank from service.

### 11.11 Pumps

**11.11.1** The design and materials of construction shall be suitable for use with liquid LPG and the service conditions, including the maximum outlet pressure to which they may be subjected. Cast irons should not be used unless they have adequate ductility and resistance to brittle fracture over the range of pressures and temperatures involved which can be as low as the boiling point of LPG being handled. Ductile iron shall be BS 2789 with an elongation at fracture of not less than 18 % is acceptable.

**11.11.2** The rotational speed of the drive should have controls to prevent the rating of the pump from being exceeded.

**11.11.3** In addition to any internal pump over pressure by-pass, the pump or adjacent piping must be fitted with a separate by-pass valve set at a lower differential pressure to automatically carry any excess liquid back to the carrying tank when the delivery valve is closed. The by-pass valve should be suitably sized to accommodate the pump discharge flow rate.

**11.11.4** A suitable strainer should be fitted to the inlet of the pump. If the strainer does not protect the pump during uplift, provision for a second strainer must be made.

### 11.12 Meters

**11.12.1** The design and materials of construction shall be suitable for use with liquid LPG and the service conditions. Cast irons should not be used unless they have adequate ductility and resistance to brittle failure over the range of pressures and temperatures to which they may be subjected which can be as low as the boiling point of LPG being handled. Ductile iron with an elongation at fracture of not less than 18 % is acceptable.

**11.12.2** Means shall be provided to eliminate vapor from the liquid phase LPG before it passes into the meter measuring chamber.

**11.12.3** A means of measuring the liquid temperature shall be provided for meters which do not have automatic temperature compensation and should be located in pipe work leading to the meter.

### 11.13 Thermometers

For temperature measurement of LPG (optional), a thermometer pocket shall be a blind tube of suitable length constructed to the design code of the tank or piping into which it is permanently welded.

### 11.14 Pressure gauges

A pressure gauge shall be provided and connected to the vapor space. It shall be protected by a manual shut-off valve and excess flow valve unless the connection through the tank is 1.4 mm diameter or less.

### 11.15 Hoses and end couplings

**11.15.1** Hoses must be resistant to LPG. If wire braid is used for reinforcement, it shall be of corrosion proof material such as stainless steel.

**11.15.2** Hoses shall be designed for a working pressure of 24 bars (350 psig).

**11.15.3** Hose assemblies, after the installation of connections, shall have a design capability to withstand a pressure of not less than 48 bars (700 psig). If a test is performed, such assemblies shall not leak when tested at pressures higher than the working pressure 24 bars (350 psig) of the hose.

**11.15.4** Hoses must be electrically continuous throughout its length and the electrical continuity shall exist between the tank and the hose free-end coupling.

**11.15.5** Hoses must be in one manufactured length without intermediate joints or couplers.

**11.15.6** Hose end valves should have a suitable secure storage location to prevent movement when the vehicle is in motion.

### 11.16 Testing and examination of bulk LPG transport

**11.16.1** The tank and pressure containing piping shall undergo a thorough examination every 5 years. Relief valves shall be replaced with new valves every 10 years. Transfer hoses and end fittings shall likewise be subjected to a thorough inspection and testing.

**11.16.2** The tank shall be subjected to the following tests:

a) Non-destructive testing of all attachment welds on the tank wall internally and externally, e.g. magnetic particle test, dye penetrant test on nozzle welds and structure attachment fillet welds.

b) Ultrasonic thickness gauging of the tank shell.

c) Hydrostatic test at 1.5 times the design pressure and subsequent visual inspection to determine whether detrimental conditions have arisen.

d) Any repairs considered necessary shall be undertaken by a trained and competent person who has a thorough understanding of the methods of construction contained in the relevant design code.

**11.16.3** All other welds on the tank mounting should also be subjected to a thorough visual inspection for cracks and/or corrosion.

**11.16.4** Any defects found should be rectified in accordance to relevant code before the tank is returned back in service.

**11.16.5** All LPG tanks shall be subjected to internal and/or external inspection, including hydrostatic tests equal to 1.2 times the maximum working pressure at intervals not exceeding five (5) years for other gas cylinders. However, internal inspection shall be conducted on such tank at any time within this period if in the opinion of the competent authority, said inspection is deemed necessary due to known or inspected defects.

**11.16.6** The result of the internal and/or external conduct of inspection on all pressure vessel parts and appurtenances, may upon the discretionary power/privilege of the inspection authority, decide whether or not to subject the pressure vessel to a hydrostatic test.

### 11.17 Accident damage

A tank or its associated pipe work or equipment which has been subject to accident damage in such a way that it may affect its safety, must not be returned to service until it has satisfactorily passed the necessary inspection procedures, outlined above. Any repair considered necessary must be undertaken by a trained and competent person who has a

thorough understanding of methods of construction contained in the PSME, ASME Code Section VIII and NFPA 58.

## 12 Fire protection, safety and security

### 12.1 General

**12.1.1** Fire protection shall be provided for all utility gas plants.

a) The extent of fire protection shall be determined by an evaluation based on the following:
   i. Type (refrigerated or non refrigerated), quantity, and size of storage tanks;
   ii. Local conditions;
   iii. Hazards within the facility; and
   iv. Exposure to and from other property.

b) The evaluation shall consider the following, as a minimum:
   i. Time of response and effectiveness of local emergency response agencies;
   ii. Type, quantity, and location of equipment necessary for the detection and control of potential non process and electrical fires;
   iii. Methods necessary for protection of equipment and structures from the effects of fire exposure;
   iv. Fire protection water systems;
   v. Fire-extinguishing and other fire control equipment;
   vi. Automatic shutdown equipment, including the types and location of sensors to initiate manual or automatic operation;
   vii. Availability and duties of individual plant personnel and availability of external response personnel during an emergency;
   viii. Protective equipment and special training needed by individual plant personnel for their respective emergency duties; and
   ix. Need for permanently mounted combustible gas detection system or permanently mounted fire detection system.

**12.1.2** The wide range in size, design, and location of facilities covered by this code precludes the inclusion of detailed fire protection provisions completely applicable to all facilities.

**12.1.3** A detailed emergency procedure manual shall be prepared to cover the potential emergency conditions that can develop whether or not a fire has occurred.

a) Emergency procedures shall include, but not necessarily be limited to, the following:

   i. Shutdown or isolation of various portions of the equipment and other applicable steps to ensure that the escape of gas or liquid is promptly cut off or reduced as much as possible;
   ii. Use of fire protection facilities;
   iii. Notification of public authorities;
   iv. First aid; and
   v. Duties of personnel.

b) The emergency procedures manual shall be kept in the operating control room or at a constantly attended location if the plant site is not continually manned.

c) The emergency procedures manual shall be reviewed and updated annually and as required by changes in equipment or procedures.

**12.1.4** All personnel shall be trained in their respective duties contained in the emergency procedures manual.

**12.1.5** Those personnel responsible for the use of fire protection or other plant emergency equipment shall be trained annually in the use of that equipment.

**12.1.6** The planning of effective fire control measures shall be coordinated with the authority having jurisdiction and local emergency-handling agencies, such as fire and police departments, which are expected to respond to such emergencies.

### 12.2 Fire and leak detection

**12.2.1** Those areas, including enclosed buildings that have a potential for flammable gas concentrations and fire shall be monitored as determined by the evaluation required in 12.1.1.

**12.2.2** Continuously monitored flammable gas detection systems shall alarm at the plant site and at a constantly attended location if the plant site is not continuously manned.

**12.2.3** Flammable gas detection systems shall alarm at not more than 25 percent of the lower flammable limit of the gas or vapor being monitored.

**12.2.4** Fire detectors shall alarm at the plant site and at a constantly attended location if the plant site is not continually manned.

### 12.3 Tank protection

Non-refrigerated storage containers shall be protected against fire exposure by one of the following means, unless an evaluation in accordance with 5.2.2 of the NFPA 59 indicates that protection is not needed.

### 12.4 Fire protection water systems

**12.4.1** A water supply and a system for distributing and applying water shall be provided for protection of exposures; cooling containers, equipment, and piping; and controlling un-ignited leaks and spills unless an evaluation in accordance with 12.1.1 indicates that the use of water is unnecessary or impractical.

**12.4.2** The design of fire water supply and distribution systems, where used, shall provide for the simultaneous supply of those fixed fire protection systems involved in the maximum single incident expected in the plant, including monitor nozzles, at their design flow and pressure.

a) An additional supply of 63 L/sec (1000 gal/min) shall be available for hand hose streams for a period of not less than 2 hours.

b) Manually actuated monitors shall be permitted to be used to augment hand hose streams.

**12.4.3** The planning for the response to incidents, including the inadvertent release of LPG, fire, or security breaches, shall be coordinated with local emergency response agencies such as fire and police departments. Planning shall include the safety of emergency personnel, workers, and the public.

Fire protection shall be provided for installations with an aggregate water capacity of more than 15.1 $m^3$ (4000 gal). The modes of such protection shall be specified in a written product release prevention and incident preparedness review. The review shall be made available to the authority having jurisdiction and local emergency responders upon request. The product release prevention and incident preparedness review shall be reviewed and revised when storage capacity or transfer equipment is modified.

a) A primary consideration in any such product release prevention and incident preparedness review shall be an evaluation of the total product control system, including emergency shutoff and internal valves equipped for remote closure and automatic shutoff using thermal (fire) actuation pull away protection and the optional requirements of Section 5.9 of NFPA 59, if used.

b) Where a written fire safety analysis exists, a product release prevention and incident preparedness review shall not be required.

c) If in the preparation of the product release prevention and incident preparedness review it is determined that a hazard to adjacent structures exists that exceeds the protection provided by the provisions of this code, special protection shall be provided in accordance with 12.4.

**12.4.4 Special protection**

**12.4.4.1** If insulation is used, it shall comply with NFPA 290, Standard for Fire Testing of Passive Protection Materials for Use on LP-Gas Containers.

**12.4.4.2** If mounding is used, the provisions under 4.6.9 shall constitute adequate protection.

**12.4.4.3** If burial is used, the provisions under 4.6.8 shall constitute adequate protection.

**12.4.4.4** If water spray fixed systems are used, they shall comply with NFPA 15, Standard for Water Spray Fixed Systems for Fire Protection, and shall be automatically actuated by fire-responsive devices and also shall have a capability for manual actuation.

**12.4.4.5** If monitor nozzles are used, they shall be located and arranged so that tank surfaces likely to be exposed to fire will be wetted. Such systems shall otherwise comply with NFPA 15, Standard for Water Spray Fixed Systems for Fire Protection, and shall be automatically actuated by fire-responsive devices and also shall have a capability for manual actuation.

**12.4.5** Fire protection water systems, where used, shall be designed, installed, and maintained in accordance with the following NFPA standards, as applicable, considering the fire control problems in facilities covered by this standard:

a) NFPA 13, Standard for the Installation of Sprinkler Systems
b) NFPA 14, Standard for the Installation of Standpipe and Hose Systems
c) NFPA15, Standard for Water Spray Fixed Systems for Fire Protection
d) NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection

e) NFPA 22, Standard for Water Tanks for Private Fire Protection
f) NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances
g) NFPA 1961, Standard on Fire Hose
h) NFPA 1962, Standard for the Inspection, Care, and Use of Fire Hose, Couplings, and Nozzles and the Service Testing of Fire Hose
i) NFPA 1963, Standard for Fire Hose Connections

### 12.5 Fire-Extinguishing and other fire control equipment.

**12.5.1** Portable or wheeled fire extinguishers that are recommended for gas fires of the dry chemical type shall be available at strategic locations, as determined in accordance with 14.1.1, within the facility.

**12.5.2** The minimum size portable dry chemical extinguisher shall be 8.2 kg (18 lb) with a B:C rating.

**12.5.3** Fixed fire-extinguishing and other fire control systems can be appropriate for the protection of specific hazards as determined in accordance with 12.1.1. If provided, such systems shall be designed, installed, and maintained in accordance with the following NFPA standards, as applicable:

a) NFPA 11, Standard for Low-, Medium-, and High-Expansion Foam
b) NFPA 11A, Standard for Medium- and High-Expansion Foam Systems
c) NFPA 12, Standard on Carbon Dioxide Extinguishing Systems
d) NFPA 12A, Standard on Halon 1301 Fire Extinguishing Systems
e) NFPA 16, Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems
f) NFPA 17, Standard for Dry Chemical Extinguishing Systems

### 12.6 Maintenance of fire protection equipment

Facility operators shall prepare and implement a maintenance program for all plant fire protection equipment.

### 12.7 Personnel safety

**12.7.1** Employees assigned personal protective equipment shall be trained in its proper use.

**12.7.2** Each utility gas plant shall have first-aid materials to handle a reasonably anticipated emergency.

**12.7.3** Personnel shall be advised of the danger of frostbite, which can result from contact with LPG liquid or cold refrigerants.

**12.7.4** Protective clothing and equipment shall be available.

**12.7.5** Those employees who will be involved in emergency activities, as determined in accordance with 12.1.1, shall be equipped with the necessary clothing and equipment.

**12.7.6** Protective clothing shall comply with NFPA 1971, Standard on Protective Ensemble for Structural Fire Fighting, and shall have an impermeable outer shell.

**12.7.7** Those employees requiring such protective clothing also shall be equipped with helmets, face shields, gloves, and boots that are recommended for LPG.
**12.7.8** Self-contained breathing apparatus shall be provided for those employees who are required to enter an atmosphere that could be injurious to health during an emergency.

**12.7.9** Such apparatus shall comply with NFPA1981, Standard on Open-Circuit Self-Contained Breathing Apparatus for Fire and Emergency Services, and shall be maintained in accordance with the manufacturer's instructions.

**12.7.10** A portable flammable gas detector shall be readily available.

### 12.8 Security

**12.8.1** Each facility operator shall have a security system with controlled access, which shall be designed to minimize entry by unauthorized persons.

**12.8.2** A protective enclosure including a peripheral fence, building wall, or natural barrier shall be provided to enclose major facility components, such as the following:

a) LPG storage tanks
b) Flammable refrigerant storage tanks
c) Flammable liquid storage tanks
d) Other hazardous materials storage areas
e) Outdoor process equipment areas
f) Buildings that house process or control equipment
g) Onshore loading and unloading facilities

1) The location and arrangement of protective structures shall minimize the following:
   i. Pocketing of escaping gas
   ii. Interference with the application of cooling water by fire departments
   iii. Redirection of flames against containers
   iv. Impeding egress of personnel in an emergency

2) As an alternative to fencing the operating area, devices that can be locked in place shall be provided.

3) Such devices, when in place, shall prevent unauthorized operation of any of the container appurtenances, system valves, or equipment.

**12.8.3** The provisions of 12.8.2 shall be met by either one continuous enclosure or several independent enclosures or other approved means.

**12.8.4** At least two exit gates or doors shall be provided for rapid escape of personnel in the event of an emergency.

**12.8.5** Provisions shall be made for the ready access to the facility by emergency personnel or services.

**12.8.6** Illumination shall be provided as necessary in the vicinity of protective enclosures and in other areas to promote security of the facility.

## 13 Resiliency Statement

Any new downstream oil facility shall be constructed and operated with high regard to the latest design and operational requirement to address natural events such as earthquakes, fault movement, storm surge, flooding or typhoon conditions as recognized by competent government agencies most likely to affect the general area where the facility shall/is to be located.

**13.1** All energy industry participants must have DOE Resiliency Compliance Plan (RCP) pursuant to Department Circular No. DC 2018-01-0001 "Adoption of Energy Resiliency in the Planning and Programming of the Energy Sector to Mitigate Potential Impacts of Disaster"

**13.2** Effective risk assessment shall put into account, but not necessarily be limited to the following:

i. Identify and analyze risk involve
ii. Assess risk potential and impact
iii. Identify controls to mitigate and reduce risk
iv. Implement the control measure as plan

**13.3** As a guide, a facility owner may use the template (Table 17) in the conduct of its individual facility risk assessment.

**Table 17 – Hazard/Risk Assessment**

| **Description of Hazard/Risk** | ***Possibility of Occurrence** | ****Severity of Impact** | **Control Measure (Include Engineering, Administrative and PPE)** |
|---|---|---|---|
| | | | |
| Name of Person who conducted the assessment | | Signature | Date |
| Name of Supervisor | | Signature | Date |

*rated as low, medium or high
**rated from 1 to 5, 1 being the lowest in terms of severity of impact and 5 being highest

## Annex A

(Informative)

### A.1 Handling and transfer of LPG product

This clause applies to LPG product loading, unloading or transfer in bulk from one tank to another wherever this transfer involves connections and disconnections in the system or the venting of LPG vapor to the atmosphere.

### A.2 Handling and Transfer of LPG product

**A.2.1** The transfer of LPG by pressure differential using fuel gas or inert gas at a pressure higher than the pressure of the LPG in the container being filled shall be permitted in accordance with the following:

a) Two backflow check valves and a manually operated shutoff valve shall be installed in the fuel gas or inert gas line or system in series to prevent LPG from flowing back into the fuel gas or inert gas line or system;
b) Any fuel gas or inert gas used to obtain a pressure differential to move liquid LPG shall be non-corrosive and dried to avoid stoppage by freezing; and
c) Before any fuel gas or inert gas is placed in a tank car for unloading LPG by pressure differential, permission shall be obtained and documented.

**A.2.2** Written procedures shall be available to cover all transfer operations, and they shall cover emergency as well as normal operating procedures. Written procedures shall be reviewed and updated at least annually and shall be available to all personnel engaged in transfer operations.

**A.2.3** The maximum vapor pressure of product at 40 °C (104 °F) that can be transferred into a container shall be in accordance with 4.1.8.6 and 4.1.8.7

**A.2.4** Isolation valve and bleed connections shall be provided at the loading or unloading manifold for both liquid and vapor return lines so that hoses and arms can be blocked off, drained of liquid, and de-pressured before disconnecting. Bleeds or vents shall discharge to a safe area.

**A.2.5** Caution shall be exercised to ensure that only those gases for which the system is designed, examined, and listed are employed in its operation, particularly with regard to pressures.

### A.3 Arrangement and operation of transfer systems

**A.3.1** Public access to areas where LPG is stored and transferred shall be prohibited except where necessary for the conduct of normal business activities.

**A.3.2** Sources of ignition shall be turned off during transfer operations, while connections or disconnections are made, or while LPG is being vented to the atmosphere.

**A.3.3** Internal combustion engines within 4.6 m (15 ft) of a point of transfer shall be shut down while such transfer operations are in progress, with the exception of the following:

a) Engines of LPG cargo tank vehicles constructed and operated in compliance with Chapter 9 of the NFPA 58 (Vehicular Transport for LPG) while such engines are driving transfer pumps or compressors on these vehicles to load containers in accordance with Section 6.5.4 of NFPA 58; and
b) Engines installed in buildings as provided in Section 11.12 of NFPA 58.

**A.3.4** Smoking, open flame, portable electrical tools, and extension lights capable of igniting LPG shall not be permitted within 7.6 m (25 ft) of a point of transfer while filling operations are in progress.

**A.3.4.1** Metal cutting, grinding, oxygen-fuel gas cutting, brazing, soldering, or welding shall not be permitted within 10.7 m (35 ft) of a point of transfer while filling operations are in progress.

**A.3.4.2** Materials that have been heated above the ignition temperature of LPG shall be cooled before that transfer is started.

**A.3.4.3** Sources of ignition shall be turned off during the filling of any LPG container on the vehicle.

### A.4 Location of bulk loading and unloading facility

**A.4.1** Loading and unloading connections shall at least be 23m (75ft) from uncontrolled sources of ignition, process areas, control buildings, offices, shops, and other occupied or important plant structures, other than equipment directly associated with the transfer operation.

**A.4.2** Loading / unloading facilities should be sited in accordance with Table 3. Consideration should also be given to their area classification (electrical) as shown in Table 12.

### A.5 Loading and unloading facility spacing

**A.5.1** Filling pipe inlet terminals shall meet all the following requirements:

a) The filling pipe inlet terminal shall not be located inside a building.
b) Such terminals shall be located at least 7.6 m (25 ft) from a container and shall be supported and protected from physical damage by vehicular movement.
c) Filling pipe inlet terminals shall be located at least 1.5 m (5 ft) behind any barriers provided for such protection.

### A.5.2 Operational Safety

**A.5.2.1** Public access where product loading or unloading operation is being conducted shall be prohibited. Only attending qualified personnel of the re-fill plant, the driver and helper of the delivery tank trailer/ lorry shall be allowed. (NOTE This implies that driver and helper of the delivery truck shall also be governed by item A.6.2 below).

**A.5.2.2** Sources of ignition or possible sources of ignition shall be turned off during loading or unloading operation, while connections or disconnections are made, or while LPG vapor is vented to the atmosphere.

**A.5.2.3** Internal combustion engines within 4.6 m (15 ft) of a point of transfer shall be shut down while loading or unloading operation is in progress, except of the following:

a. Engines of LPG tank trailer/lorry constructed and operated in accordance to Chapter 9 of NFPA 58 while such engines are driving transfer pumps or compressors on these vehicles.

**A.5.2.4** Smoking, open flame, portable electric tools and extension lights capable of igniting LPG shall not be permitted within 7.6 m (25 ft) of a point of transfer while loading or unloading is going on.

**A.5.2.5** Metal cutting, grinding, oxygen-fuel cutting, brazing, soldering or welding shall not be permitted within 10.7 m (35 ft) of a point of transfer while loading or unloading is going on.

**A.5.2.6** Tank trailer/ lorry loading to bulk storage tank shall be at least 15.0 m (50 ft) away from the tank and so positioned that the shut-off valves on both the storage tank and vehicle are readily accessible.

**A.5.2.7** Where the intake of any air-moving equipment (example room air conditioner) is less than 15 m (50 ft) from a point of transfer it shall be shut down while loading or unloading is going-on.

**A.5.2.8** During loading or unloading operation, the delivery tank trailer or tank lorry shall be provided with wheel chocks under the tires to prevent it from moving, provided at least of (2) x 9 kgs B:C fire extinguishers placed on the ground near the vehicle (readily accessible and ready for use) and properly grounded by attaching vehicle grounding cable to the grounding receptacle or pole of the bulk loading/unloading gantry.

**A.5.2.9** Loading / unloading facilities shall be located so that the safe positioning of the delivery vehicle and its quick removal in an emergency is facilitated.

### A.6 Transfer personnel qualifications

**A.6.1** Persons engaged in gas operating and emergency procedures and in the handling of liquefied petroleum gases shall be trained in the properties and safe handling of these gases and in emergency procedures. This training shall be repeated at least annually.

**A.6.2** Loading and unloading operations shall be conducted by a company authorized personnel trained and competent in proper handling procedures. "*Refresher*" training shall be provided at least every (3) years. This training shall be documented. (Note: "*Refresher*" means that the periodic training could be less intensive than the original training, whose primary purpose is to reinforce initial training rather than repeat it.

**A.6.3** Transfer operations shall be conducted by individuals familiar with the properties of the product and instruction in transfer and emergency procedures. At least one trained and competent person shall remain in attendance during the entire period of transfer from the time connections are made until the transfer is completed, shutoff valves are closed, and lines are disconnected.

**A.6.4** At least one trained and company authorized personnel shall remain in attendance at the loading or unloading operation from the time of connections are made until the operation is completed, shut-off valves are closed, and lines are disconnected.

**A.6.5** Loading and unloading personnel shall exercise precaution to ensure that the LPG transferred are those for which the transfer system and the tank to be filled is designed.

## A.7 Tank truck vehicle loading and unloading

**A.7.1** The cargo tank vehicle transfer area shall be relatively level.

**A.7.2** A cargo tank vehicle transfer area shall be of sufficient size to accommodate the vehicles without excessive movement or turning. Cargo tank vehicles that unload into or load from storage tank shall be at least 15 m (50 ft) from the tank and positioned so that the shutoff valves on both the truck cargo tank vehicle and the transfer station are readily accessible.

**A.7.3** When cargo tank vehicles are loading or unloading, the wheels shall be blocked and operating personnel shall remain in attendance.

## A.8 Operating records

**A.8.1** Each facility shall maintain a record of all operating log sheets and recorded data. These records shall be made available to the authority having jurisdiction upon request during normal office hours.

**A.8.2** Operating log sheets required under A.8.1 shall be retained for at least 5 years.

## A.9 Operations

### A.9.1 Operating procedures manuals

**A.9.1.1** Each facility shall prepare and maintain written operating procedures manuals that cover facility start-up, operation, and shutdown.

**A.9.1.2** Operating procedures manuals shall include operator actions to be taken if flammable concentrations of flammable liquids or gases are detected in the facility using the following:

a) Fixed detectors
b) Portable detectors
c) Operating malfunctions
d) Human senses

**A.9.1.3** Where human senses are relied on, a schedule of tours of the facility shall be included in the operating procedures.

**A.9.1.4** Operating procedures shall include procedures for purging and inerting equipment.

**A.9.1.5** Operating procedures for vaporizers shall include the following:

a) Maintenance of vaporization rate
b) Pressure control
c) Temperature control
d) Specific actions to be taken when parameters exceed normal operating limits and criteria for emergency shutdown

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the references document (including any amendments) applies.

**ANSI**, American National Standards Institute

API 607, Fire Test for Soft-Seated Quarter-Turn Ball Valves 4th Edition
API 2510A 2nd edition Dec. 1996 - Fire Protection Considerations for the Design and Operation of Liquefied Petroleum Gas (LPG) Storage Facilities
API 2510, Design & Construction of LPG Installation

ASCE 7, Minimum Design Loads for Buildings and Other Structures
ASME A13.1-2007, Scheme for the Identification of Piping Systems
ASME, Boiler and Pressure Vessel Code
PNS ASME B 31.3:2005 Processed Piping
ASME Code Section VIII Div. 1 (Rules for Construction of Pressure Vessels) and Section VIII Div. 2 (Alternative Rules)

ASTM A 395, Specification for Ferretic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM A 536, Specifications for Ductile Iron Casting
ASTM A 47, Standard Specification for Ferretic Malleable Iron Castings

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*
NFPA 30, *Flammable and Combustible Liquids Code*
NFPA 51B, *Standard for Fire Prevention During Welding, Cutting and Other Hot Work*
NFPA 70, *National Electrical Code*
NFPA 77, *Recommended for Static Electricity*
NFPA 290, *Standard for Fire Testing of Passive Protection Materials for Use on LP-Gas Containers*
NFPA 326, *Standard for the Safeguarding Tanks for Entry, Cleaning or Repair*
NFPA 780, *Standard for the Installation of Lighting Protection Systems*
NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting*
NFPA 1981, *Standard on Open-Circuit Self Contained Breathing Apparatus for Fire and Emergency Services*

Philippine Society of Mechanical Engineers Code

UL 132, *Standard on Safety Relief Valves for Anhydrous Ammonia and LP-Gas*

BS 5500, Specifications for Unfired Fusion

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